
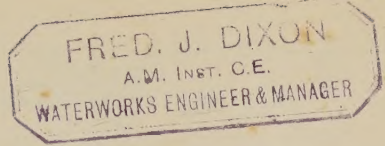




UNIVERSITY OF LANCASTER
LIBRARY



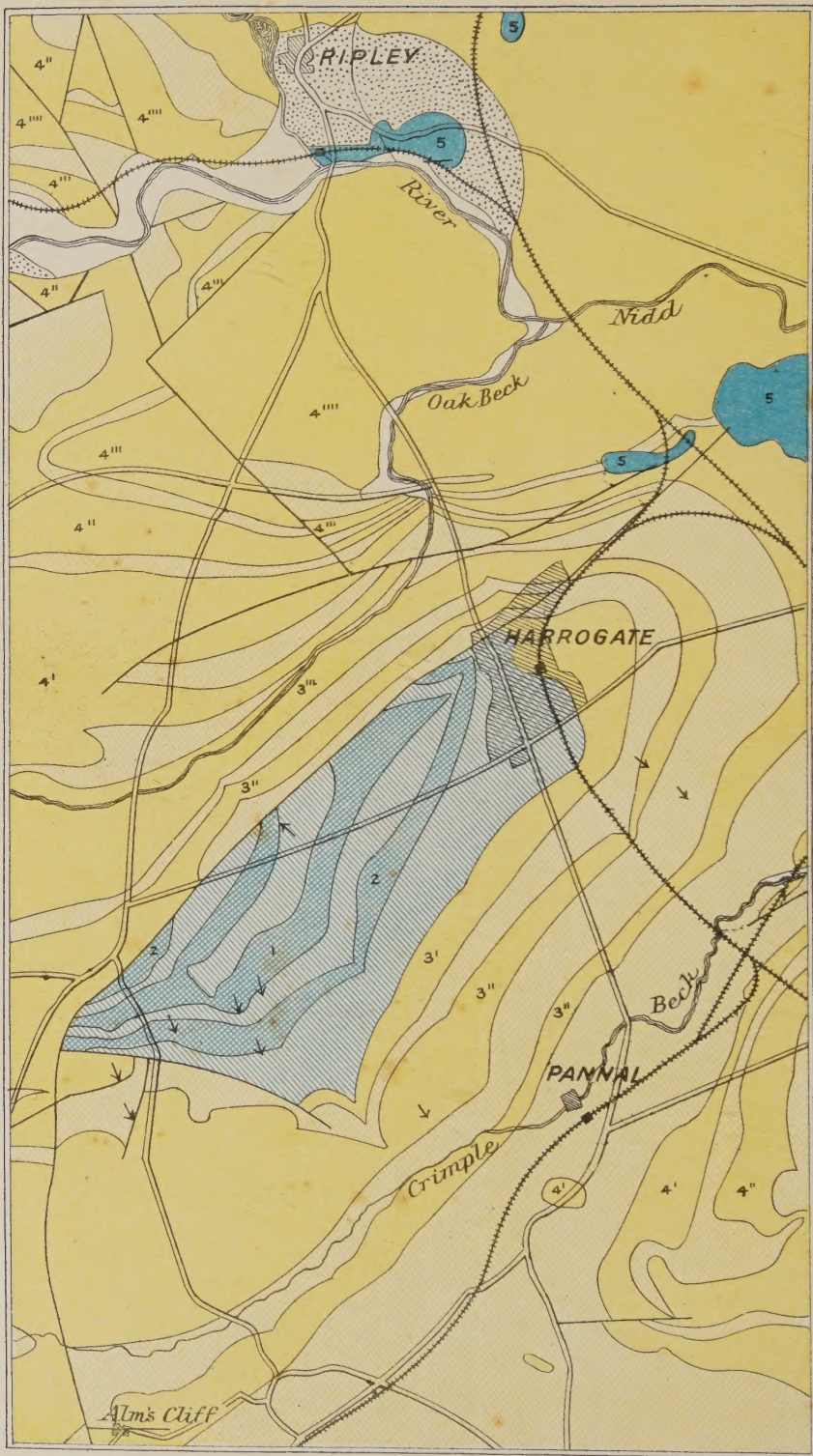
Digitized by the Internet Archive
in 2025



FRED. J. DIXON

A.M. INST. C.E.

WATERWORKS ENGINEER & MANAGER



MEMOIRS OF THE GEOLOGICAL SURVEY
ENGLAND AND WALES.

EXPLANATION OF SHEET 62.

(93 NW. OLD SERIES.)

THE GEOLOGY OF
THE COUNTRY NORTH AND EAST OF
HARROGATE.

BY
C. FOX-STRANGWAYS, F.G.S.

SECOND EDITION.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.



LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN & SONS, LIMITED, FETTER LANE, E.C.

And to be purchased from
E. STANFORD, 12, 13, and 14, LONG ACRE, LONDON;
W. & A. K. JOHNSTON, LTD., 2, ST. ANDREW SQUARE, EDINBURGH;
HODGES, FIGGIS & Co., GRAFTON STREET, DUBLIN;
From any Agent for the sale of Ordnance Survey Maps; or through any
Bookseller from the Ordnance Survey Office, Southampton.

1908.

Price Two Shillings and Sixpence.

DGV

ea

G

79/00066

PREFACE.

Since the first edition of this Memoir was published, thirty-four years ago, additional information as to the geology of the district has been obtained, especially with reference to the glacial deposits of the Vale of York. The physical history of the district as revealed by these deposits has been the subject of important researches by Prof. Carvill Lewis, Prof. Kendall, and others, and advantage has been taken of the necessity of a new edition of the Memoir to refer to these researches.

In the preparation of this edition we have fortunately been able to secure the services of the original author, who has also added new matter relating to the structure of the area, the alteration of the river courses, the history and origin of the celebrated Harrogate Springs, and an extensive bibliography dealing with the geology of the district, and all subjects relating to the springs, except such as are of a purely medical character.

Our thanks are due to Mr. Godfrey Bingley for the photographic illustrations of some of the more remarkable features of the district.

J. J. H. TEALL,
Director.

*Geological Survey Office,
28, Jermyn Street, London.
2nd September, 1908.*

CONTENTS.

| | PAGE |
|--|------|
| PREFACE by the Director - - - - - | iii |
| CHAPTER I.—INTRODUCTION. Physiography, Classification and Table of Strata - - - - - | 1 |
| CHAPTER II.—CARBONIFEROUS. Harrogate Roadstone Series and Millstone Grit - - - - - | 4 |
| CHAPTER III.—PERMIAN. Magnesian Limestones and Marls - | 11 |
| CHAPTER IV.—TRIAS. Bunter and Keuper Sandstones, Keuper Marl. Rhætic Beds - - - - - | 16 |
| CHAPTER V.—LIAS. Lower Lias, Middle Lias, Upper Lias - | 19 |
| CHAPTER VI.—SUPERFICIAL DEPOSITS. Glacial Beds. Post Glacial Beds—Warp and Lacustrine Beds, Mammalian Gravels, Alluvium and River Terraces - - | 21 |
| CHAPTER VII.—PHYSICAL STRUCTURE. Folds and Faults. Geo- logical Structure, Scenery and River courses - | 26 |
| CHAPTER VIII.—ECONOMIC GEOLOGY. Mineral Waters, Building Stone, Lime, Coal, Sand and Gravel, Gypsum, Celestite, Strontianite, Copper, Water Supply - | 33 |
| CHAPTER IX.—HISTORY AND ORIGIN OF THE HARROGATE SPRINGS | 42 |
| APPENDIX I.—BORINGS AND WELL SECTIONS - - - - - | 53 |
| APPENDIX II.—BIBLIOGRAPHY - - - - - | 61 |
| INDEX - - - - - | 94 |

ILLUSTRATIONS.

I. PLATES.

| | | | |
|-------|---|----------------------|----|
| Plate | I.—Geological Map of the Country around Harrogate | <i>Frontispiece.</i> | |
| | (Scale, 1 inch to a mile). | | |
| Plate | II.—Banks of the River Nidd, Knaresborough. | | |
| | Magnesian Limestone resting on Millstone | | |
| | Grit - - - - - | to face page | 8 |
| Plate | III.—The Devil's Arrows, Boroughbridge. | | |
| | Mono-liths of Millstone Grit - - - | to face page | 9 |
| Plate | IV.—Plumpton Rocks. Showing the curious weather- | | |
| | ing of this portion of the Millstone Grit | to face page | 10 |
| Plate | V.—Grimbald Crag, Knaresborough. | | |
| | Magnesian Limestone on Millstone Grit - - | to face page | 13 |
| Plate | VI.—Birk Crags near Harrogate. | | |
| | Kinder Scout Grit dipping 43° to the N.W. - - | to face page | 27 |
| Plate | VII.—The Dropping Well, Knaresborough. | | |
| | Crag of Magnesian Limestone covered with tufa | to face page | 34 |
| Plate | VIII. A.—Section across the Harrogate anticline | | |
| | and the Millstone Grit on the western side | | |
| | of the map. | | |
| | B.—Section across the Vale of York from | | |
| | Farnham to Crayke illustrating the general | | |
| | succession of the strata - - - | to face page | 52 |

II. WOODCUTS.

| | PAGE. |
|--|-------|
| Fig. 1.—Newsome Bridge Quarry - - - - - | 8 |
| Fig. 2.—St. Helen's Quarry - - - - - | 9 |
| Fig. 3.—Sand-pit near Brearton - - - - - | 11 |
| Fig. 4.—Sand-pit at New Covert, near Scriven - - - - - | 12 |
| Fig. 5.—Section across the Nidd at Nidd Rock - - - - - | 29 |
| Fig. 6.—Fault at Goldsborough Mill - - - - - | 29 |

THE GEOLOGY

OF THE COUNTRY NORTH AND EAST OF

HARROGATE.

CHAPTER I.

INTRODUCTION.

The new series Sheet 62, known previously as quarter-sheet 93 N.W. (old series), may be said to comprise the valley of the Ouse from Ripon to York, or, roughly speaking, the central part of the Vale of York. The area contained in the map is 216 square miles. The chief towns are Harrogate, Knaresborough, Borough-bridge, and Easingwold, with the southern suburb of Ripon; the map also extends, on the south-east, to within three miles of the city of York.

The principal rivers are the Ouse, the Ure, the Swale, and the Nidd, which all rise in the high ground in the north-west of the county, and uniting into one stream, in this map, enter the German Ocean by the estuary of the Humber. Thus the river system belongs entirely to the basin of the Ouse, the name by which the united streams are known below their junction with the small rivulet flowing from Great Ouseburn. The direction of all the streams is more or less easterly, and is due to the general inclination of the Permian and Triassic rocks being in that direction. The earth movements which have thrown the older rocks into anticlinal and synclinal folds have had no influence in determining the lines of drainage. It will be seen later on that this easterly drainage was much interfered with during Glacial times, and that the original courses of many of the streams were changed during that epoch.

The ground rises gradually on either side of the great central valley to the north-east and west, but principally towards the west, on which side the highest ground is at Harlow Hill near Harrogate, and How Hill, near Fountains Abbey, both of which are about 600 feet above the sea. The general dip of the several formations is to the north-east, although in the western part of the district the Palæozoic rocks are thrown into a series of anticlinal and synclinal folds striking north-east and south-west, the most remarkable of which is that at Harrogate.

All the physical features of the country may be shown to be a result of its geological structure. Thus, the hard sandstones and soft shales of the Carboniferous rocks form the high ground and deep valleys in the western part of the map; these are succeeded by a lower, but well-marked ridge of Magnesian Limestone rising to an average height of between 200 and 300 feet above the sea; beyond these again are the soft marls and sandstones of Permian and Triassic age, forming part of the great central valley of Yorkshire.

A small area at the north-east corner of the map, where the ground begins to rise again in that direction, is occupied by the shaly sandstones of the Middle Lias, the soft marls and shales of the Keuper and Lower Lias being entirely hidden by an immense thickness of alluvial deposits.

The country under notice is almost entirely agricultural, there being no mines or manufactures of any extent. The principal and most prosperous place in the map is Harrogate, the importance of which is entirely due to its geological position. The sharp uplift of the lowest rocks that occur in the district, which takes place at this point, has given rise to such a variety of mineral waters that during late years Harrogate has become one of the best known health resorts in the country. The intimate connection between the geological structure of the district and the origin of these springs is of so much interest that a special chapter has been devoted to this subject.

CLASSIFICATION AND TABLE OF STRATA.

Since the publication of this map in 1874 it has been shown by Dr. Wheelton Hind that the important series of strata between the Millstone Grit and the Carboniferous Limestone of Skipton and beyond are not the homotaxial equivalent of the Yoredale Shales of north-west Yorkshire. Consequently the term Yoredale has been withdrawn for the description of these beds in the present memoir, as it is probable that they should be referred to the southern series rather than to those of Wensleydale.

The red grits at the base of the Magnesian Limestone were at one time considered to be of Permian age, but the error was pointed out long ago, and has been fully referred to elsewhere, so that it is not necessary to go into the subject further.

The age and separation of the sandstones forming the greater portion of the Trias of this part of the country has always been a matter of some doubt, and no further light has been thrown on the subject of late years.

The origin of the Glacial beds and the physical geography of that period has been rendered much clearer by the work of Professor P. F. Kendall in this county since the first edition of the memoir was written.

The following list gives in descending order all the divisions and subdivisions of the strata that occur within the area:—

Table of Strata.

| | | | | | | | | |
|--------------------------|---|--|---|--------------|-------------------|-------------------|---|------------|
| RECENT AND POST-GLACIAL. | { | Alluvium and River Terraces. | | | | | | |
| GLACIAL - - - | | Warp and Lacustrine Clay, Sand and Gravel. | | | | | | |
| | | Glacial Clays, Sands and Gravels. | | | | | | |
| JURASSIC - - - | { | Upper Lias. | | | | | | |
| | | Middle Lias. | | | | | | |
| | | Lower Lias. | | | | | | |
| TRIAS - - - | { | Rhætic. | | | | | | |
| | | Keuper. | | | | | | |
| | | Bunter. | | | | | | |
| PERMIAN - - - | { | Upper Magnesian Limestone. | | | | | | |
| | | Middle Marl. | | | | | | |
| | | Lower Magnesian Limestone. | | | | | | |
| | | Lower Marl and Sands. | | | | | | |
| CARBONIFEROUS - | { | Millstone Grit - | { | Third Grit. | { | Plumpton Grit. | | |
| | | | | | | Shales. | | |
| | | | { | Fourth Grit. | { | Cayton Gill Beds. | | |
| | | | | | | Shales. | | |
| | | | | | | Follifoot Grit. | | |
| | | | | | | Shales. | | |
| | | { | { | { | Kinder Scout Grit | | | |
| | | | | | in three beds. | | | |
| | | | | | { | { | { | Shales. |
| | | | | | | | | Roadstone. |
| Shales. | | | | | | | | |
| Grit. | | | | | | | | |
| | | | | | | Shales. | | |

All the subdivisions in the Table are represented by distinct colours except the Drift, which at the time this country was surveyed was not shown on the map. A considerable amount of Boulder clay and gravels, however, occurs in the district, and obscures the rocks that lie beneath, so that many of the boundaries are very uncertain. For this reason many of the boundaries between the Permian Marls and Limestone are very doubtful; while that between the Permian and Trias is entirely conjectural, the junction between these formations not having been observed at any point, although by aid of well sections its approximate position is not difficult to fix. The boundary between the Trias and the Jurassic rocks is also entirely concealed by superficial beds, but its approximate position and the general structure of these underlying rocks can be made out from a study of the country further to the east, which shows that the strata are much disturbed by lines of fault. These lines of fault are not shown beneath the superficial beds on this map, but their general position may be gathered from the four miles to an inch map of this district.

CHAPTER II.

CARBONIFEROUS.

HARROGATE ROADSTONE SERIES.

The lower Carboniferous rocks of Yorkshire were formerly divided by Professor Phillips into the two main divisions of Lower Scar Limestone and Yoredale Rocks; but it has since been pointed out by Dr. Wheelton Hind that the second of these names cannot be applied to the series in the southern part of the county, from the fact that the beds which occur in the typical district of Yoredale or Wensleydale are on a different horizon to those of similar character in the south. Dr. Hind has shown that the true Yoredale beds are the homotaxial equivalent of the upper part of the Carboniferous Limestone, and consequently that it is erroneous to apply this name to the beds above the Limestone in the southern area. For these latter he proposes the name Pendleside series, from Pendle Hill where the beds are thickest and best exposed.

The district we are at present concerned with lies midway between these two places, and it is doubtful to which type the beds at Harrogate should be assigned. The typical Pendleside series dies out at about this latitude, and as the rocks at Harrogate contain few organic remains except Crinoids, there are no palaeontological data by which the horizon of these beds can be definitely determined.*

The nearest exposure of these rocks is in the valley of the Wharfe about Bolton Abbey; but the beds, which here crop out beneath Beamsley Beacon, are so different in character from those of the Harrogate inlier that they throw no light on this section.

At Harrogate these beds consist, for the most part, of shales with a few bands of cherty limestone, and one tolerably massive bed of sandstone near the base. This sandstone is well seen in a line of quarries on How Hill near Harrogate; it is here a thin-bedded but somewhat hard sandstone, of a whitish colour, and contains on its surface a white efflorescence. On the northern side of Harlow Hill this rock is more decomposed, and near the surface has a rubbly and somewhat sandy or gritty nature.

The limestone is an exceedingly hard silicious rock containing Emericites in great numbers, in fact in many cases it is rather an aggregated mass of the silicified remains of these than a limestone proper; when by exposure to air and moisture the calcareous portion of the rock becomes dissolved out, it has very much the appearance and texture of pumice stone, and especially is this the case along the angles of flexure when the beds are much contorted.

* Professor Phillips considered the Harrogate roadstone to be the equivalent of the main or 12-fathom limestone at the top of the Yoredale series. *Quart. Journ. Geol. Soc.*, vol. xxi., p. 234.

Where this group of strata crops out to the west, there is no rock exactly corresponding to the Harrogate Roadstone, and it was probably formed under somewhat local and peculiar circumstances.*

The best sections of this rock are in quarries at Shaw Green, Beckwith House, and behind the Cold Bath Road, Low Harrogate, at all of which places it forms an excellent roadstone and has been quarried for that purpose.

In this district these rocks are brought up along an anticline running in a N.E. and S.W. direction, and it is owing to this peculiar structure that we have their outcrop in the country under consideration; whenever this cherty limestone is exposed to view it is either contorted or highly inclined having evidently been subjected to great disturbance.

MILLSTONE GRIT.

The lower portion only of this group of strata crops out in the district under consideration; the beds which appear in the map being the equivalents of the Third Grit, and Fourth or Kinder Scout Grit, of Derbyshire.

The Kinder Scout Grit consists of three separate beds of sandstone which, with the intermediate shales, have a thickness of nearly 1,400 feet. Both the lowest and highest of these beds are coarse, massive gritstones, frequently containing pebbles of quartz, and capable of being split by means of joints into blocks of a considerable size. The upper bed has been largely quarried for building-stone at Hookstone Wood, and several places to the south of Harrogate, and also at Birk Crag to the west and near Walker Road to the north of the town.

The middle bed of sandstone belonging to this group is not nearly so clearly defined as the other two. It consists of a thin flaggy sandstone which becomes more massive towards the base; it forms no good feature anywhere throughout the district, and not being well exposed has, apparently, been overlooked by previous observers.

That the strata which comprise this group have a considerable thickness is proved by the fact that a borehole, which was put down at the southern end of Bogs Lane, near Starbeck, near the outcrop of the upper bed failed to reach the sandstone next below, although sunk to a depth of 437 feet. This section, which is given in the Appendix, page 54, was sunk almost entirely in shale, while others nearer Starbeck were in the upper part of this rock.

The Third Grit of this area consists of many separate beds of sandstone; but several of these, owing to local thinning out, are difficult to follow for any distance. They are however divisible into three distinct series which can be easily recognised throughout the district. These which are named after the localities where they are best exemplified are the Follifoot Grits, the Cayton Gill Beds, and the Plumpton Grits.

The Follifoot Grits, so named on account of their being well seen along the edge of the hill south of the Crimple Valley, known as Follifoot Moor, usually consist of two beds, which with

* See also W. H. Hudleston, *Proc. Geol. Assoc.*, vol. vii., p. 426.

the intermediate shale have a thickness of about 200 feet; they are hard compact sandstones which in small fragments have very much the appearance of loaf sugar. To the north of Harrogate these beds form the remarkable ridge of Long Crag north of Oak Beck, and are again seen at the Gas Works, and at several places near Harrogate End. They also outcrop in the bed of the river Nidd below Bilton, but have not been separately mapped, as their course is too obscure to allow it to be done with accuracy.

At Bilton coal was formerly worked in these grits and was used for burning the Magnesian Limestone close at hand, but it was never of much importance. It occurs in two seams separated by about three or four yards of shale. The uppermost of these, which was the one principally worked, had a thickness of 3 ft. 2 in.; the lower bed, which in some places was as much as 2 ft. 9 in. in thickness, appears to thin away altogether on the northern side of the working. The coal has been worked out to the east, but on the west or dip-side it was discontinued on account of water.

In the little stream, west of Thornton Moor House, this coal was again met with at a depth of 60 ft., where it had a thickness of 18 in., but only 4 in. of this was good. It has also been worked further west at several places in the next map.

The Cayton Gill Beds, so named as the best sections of them are exposed at two or three places in that valley, are not of any great thickness, but are remarkable from their being highly fossiliferous, an unusual occurrence in beds of Millstone Grit age. In Cayton Gill these beds consist of the following sub-divisions:—

Flags with Encrinite remains. | Hard bed.

Beds full of Brachiopoda. | Black shale with fossils.

The hard beds have been quarried as a road-material at Rhodes House near Follifoot, Four Lane Ends and Saltergate Hill north-west of Harrogate, at several places on and near Scarah Moor, and by the road leading from Fountains Abbey to Sawley.

The following fossils were collected by the Survey from these beds at the several localities named:—

| | Four Lane Ends, Harrogate. | Quarry behind Hamps- thwaite Station. | Railway Cutting Hamps- thwaite. | Fountains Abbey. |
|--|----------------------------------|---|--|---------------------|
| <i>Schizophoria resupinata</i> (Mart.) | × | — | — | × |
| <i>Spirifer bisulcatus</i> <i>J. de C.</i> <i>Sow.</i> | × | × | — | — |
| <i>Spirifer striatus?</i> (Mart.) | × | — | — | — |
| <i>Orthotetes crenistria</i> (Phill.) | — | — | × | — |
| <i>Productus</i> sp. | — | — | × | × |
| <i>Rhynchonellid</i> | — | — | × | — |
| <i>Grammatodon</i> cf. <i>cancellatus</i> (Mart.) | × | — | — | — |
| <i>Stroboceras sulcatum</i> (<i>J. de</i> <i>C. Sow.</i>) | × | × | — | — |
| <i>Temnocheilus tuberculatus</i> (<i>J. Sow.</i>) | — | × | — | — |

A rather fuller list is given by the Rev. J. S. Tute. *Proc. Yorkshire Geol. Soc.*, vol. ix., p. 266, who also records an *Orthoceras* and a *Lingula* from the Millstone Grit of this district, *Ibid*, vol. vii., p. 82, and vol. ix., p. 425. *Pleuromma nodoso-carinatus* (Röm.) was found by Mr. Dixon in the shales that were excavated in making the Scargill reservoir, which are about at this horizon. The specimen is now in the British Museum.

From these beds in this neighbourhood also Dr. Wheelton Hind has lately recorded the following much fuller list.*

| | Clint Quarries. | Near Pateley Bridge. | Hazel Hill, Sawley. |
|----------------------------------|--------------------|----------------------------|------------------------|
| Fenestella sp. - - - | — | × | — |
| Chonetes cf. laguessiana - - | × | — | × |
| Derbya sp. - - - | × | × | × |
| Productus cora [late mutation] - | × | × | × |
| " longispinus - - - | × | × | × |
| " scabriculus - - - | × | — | — |
| Rhipidomella michelini - - | — | × | — |
| Schizophoria resupinata - - | × | × | × |
| Seminula ambigua - - - | × | × | — |
| Spirifer bisulcatus - - - | × | — | — |
| Spiriferina cristata - - - | × | × | — |
| Amusium concentricum - - - | — | × | — |
| Aviculopecten dissimilis - - | × | — | × |
| " semicostatus - - - | — | — | × |
| " stellaris - - - | — | — | × |
| " sp. - - - | — | × | — |
| Cypricardella sp. - - - | — | × | — |
| Edmondia maccoyi - - - | — | — | × |
| " rudis - - - | — | — | × |
| " sp. - - - | — | × | — |
| Leiopteria laminosa - - - | × | — | — |
| " squamosa - - - | — | × | — |
| " sp. - - - | — | — | × |
| Lithodomus jenkinsoni - - - | — | — | × |
| Mytilomorpha sp. - - - | — | — | × |
| Palæolima sp. - - - | — | — | × |
| Parallelodon obtusus - - - | × | × | — |
| " sp. - - - | — | — | × |
| Protoschizodus curtus - - - | — | — | × |
| Pterinopecten whitei - - - | — | — | × |
| Sanguinolites sp. - - - | × | — | × |
| Tellinomorpha cuneiformis - | — | — | × |
| Euphemus sp. - - - | — | × | × |
| Loxonema rugifera - - - | — | × | — |
| Macrochilina sp. - - - | — | — | × |
| Naticopsis sp. - - - | — | — | × |
| Ephippioceras bilobatum - - | — | — | × |
| Orthoceras sp. - - - | × | — | × |
| Stroboceras sulcatum - - - | × | × | × |
| Petalodus acuminatus - - - | × | — | — |
| Rhizodopsis sauroides - - - | × | — | — |

* *Naturalist* 1907, pp. 92, 93.

The Plumpton Grit, the highest of the Millstone Grit measures occurring in this district, consists of two beds having a total thickness of 150 feet, and composed of thick-bedded, coarse, and exceedingly massive grits. The base of the rock is often a true conglomerate containing rolled pebbles of quartz, and is very ferruginous. This rock was formerly considered as belonging to the Lower New Red sandstone of the Permian series, and to be the equivalent of the Rothliegende of the Thuringerwald in Germany,* but the sections showing the junction between the two formations are so clear in this neighbourhood that it is difficult to understand how these grits could ever have been supposed to be other than of Carboniferous age.†

The junction of the grit with the Magnesian Limestone above is well seen at several places in the southern part of the map; but, undoubtedly, the finest sections are those exposed along the banks of the Nidd below Knaresborough. Here, although the sections are not always quite clear at first sight, a decided unconformity between the two series of strata can be traced; the denuded surface of the coarse red grit of Plumpton, which is exposed in a series of fine sections, being covered directly by the Magnesian Limestone. This is more particularly the case below what is called Abbey Crag, where there is a prominent boss of red grit which rises several feet into the surrounding limestone.

At Newsome Bridge and St. Helen's quarries, in the extreme south of the map, the junction is also well shown; at the latter of these there is a small patch of red marl, with a little greenish layer below the limestone, which may be the equivalent of the lower marls.

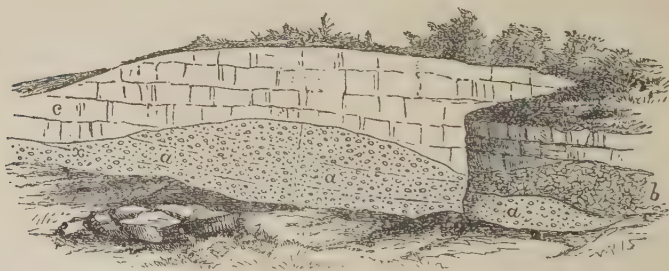


Fig. 1. *Newsome Bridge Quarry.* Drawn by J. C. Ward.

a. Whitish grit (Millstone Grit). About $\frac{1}{2}$ it contains, in quite its upper part, little horizontal patches of a soft unctuous marl.

b. Grit and limestone confusedly mixed together.

c. Yellow limestone, with included fragments of grit at its base (Permian).

* *Trans. Geol. Soc.*, ser. 2, vol. iii. p. 37; *Quart. Journ. Geol. Soc.*, vol. xxi., p. 234; Murchison's *Siluria*, 3rd Ed., p. 349.

† *Geol. Mag.*, vol. iii., p. 49; *Proc. Yorkshire Geol. Soc.* for 1867, vol. iv., p. 568; *Quart. Journ. Geol. Soc.*, vol. xxv., p. 291.



Photographed by Godfrey Bingley, Headingley, Leeds. (Copyright.)

BANKS OF THE RIVER NIDD AT KNARESBOROUGH. MAGNESIAN LIMESTONE RESTING ON MILLSTONE GRIT.



Photographed by Godfrey Bingley, Headingley, Leeds.

THE DEVIL'S ARROWS, BOROUGHBIDGE.
MONOLITHS OF MILLSTONE GRIT.



Fig. 2. *St. Helen's Quarry.* Drawn by J. C. Ward.

- a. Coarse purplish grit (Millstone Grit).
- b. Red marls, 5 ft., with a little greenish layer at top, below which is occasionally a thin layer of fine grit (redeposited) (Permian).
- c. Soft yellow limestone (Permian).

The Plumpton Grit, on account of its great durability as well as the comparative facility with which it may be worked, is largely used as a building-stone, and is quarried at a great number of places along its out-crop. South of the Nidd the best sections are those at Plumpton, near Knox Mill and near Killinghall Mills; north of the Nidd it is well seen at Knaresborough, Scriven, Lingerfield, Ripley, South Stainley, Dole Bank, and Fountains.

It is from this grit that the remarkable blocks known as the Devil's Arrows have come. These huge monoliths consist of three masses of gritstone, the origin and purpose of which has long been a puzzle to antiquaries. They are situated in some fields near the lane leading from Boroughbridge to Roecliffe, about a quarter of a mile from the former place. The blocks stand north and south and are deeply furrowed by weathering; the loftiest one is about 22 feet above the ground. There were formerly four of these stones standing in the 16th century, but one fell and was carried away to form the foundation of a bridge over the Tutt Beck. They are about eight miles in a direct line from Plumpton, and about six from South Stainley and Lingerfield, the nearest places where such a grit exists *in situ*.*

These grits, probably from their unequal hardness and thick-bedded nature, have a tendency to weather into very peculiar and fantastic shapes, as may be seen more especially at Brimham and Plumpton, as well as either side of the road between the latter place and Spofforth, where they stand up in the centre of the fields in the most picturesque manner; they are usually of a purple colour, which may, possibly, be due to the peroxidation of the iron they contain, by the action of carbonated water filtering from the limestone above through the porous grit.†

* These remarkable monoliths are noticed in nearly all the Histories and Guide Books referring to the district, but more especially by W. Camden, 1586, Gibson's edition, 1720, fol. 716; T. Gale, 1709; J. Lreland, 1710; W. Stukeley, 1724; F. Drake, 1736; E. Hargrove, 1769; T. Pennant, 1804; and J. Phillips, 1853. The full references to these are given in the Bibliography. There are also three drawings of these stones in the print room at the British Museum, Kaye v., 15-17. See also footnote, page 93.

† On the colouring of these grits see papers by J. C. Ward, *Quart. Journ. Geol. Soc.*, vol. xxv., p. 295, and *Geol. Mag.*, vol. ix., p. 389, and J. Lucas, *Geol. Mag.*, vol. ix., p. 338.

The Millstone Grit at several places is covered with a coating of calcspar, and sometimes small pieces of the rock are cemented together by the same substance; as at Fountains Abbey and other places.

There are some large detached blocks of this grit at Haddock-stones, which have been supposed to be erratics brought down by a glacier from Hebden Wood and Sawley; but there is little doubt that this rock is here *in situ*, or if it has been moved at all it is not more than can be accounted for by slipping.*

* These stones have been so named from their resemblance to shocks of corn locally termed "haddocks."



Photographed by Godfrey Bingley, Headingley, Leeds. (Copyright.)

PUMPTON ROCKS SHOWING THE CURVED WEATHERING OF THIS SECTION OF THE MILLSTONE GIRT.

CHAPTER III.

PERMIAN.

The Permian rocks of this district are capable of division into four separate alternations of strata, which are to a certain extent unconformable to each other, although this is not always very clearly seen in the country under consideration.

They consist of the following alternations of marl and limestone in descending order.

Upper Magnesian Limestone.

Middle Marl.

Lower Magnesian Limestone.

Lower Marl and Sands.

In the country to the south an upper bed of marl was exposed in a few places, but it is extremely doubtful if such a bed occurs in this district, or could be separated from the overlying Trias.

These beds occupy, as a whole, a broad strip of country in the western half of the map, running from the banks of the Nidd south of Knaresborough, to the neighbourhood of Studley Park, to the west of Ripon.

Lower Marl and Sands:—In the St. Helen's quarry there are five feet of red marl occupying a depression in the underlying grit which probably indicates the existence of these marls in the district, but the outcrop, which must be very limited, is not capable of being traced.

At Brearton some beds of marly sandstone were seen, which are also probably of this age. They are composed of soft brick-red sandstones, excessively like the Bunter sandstone, but unlike rocks of that age they are interstratified with thin seams of white unctuous clay, resembling fuller's earth. The subjoined rough sketch was taken from the sandpit at the back of the village, and may give some idea of the nature of this deposit:—

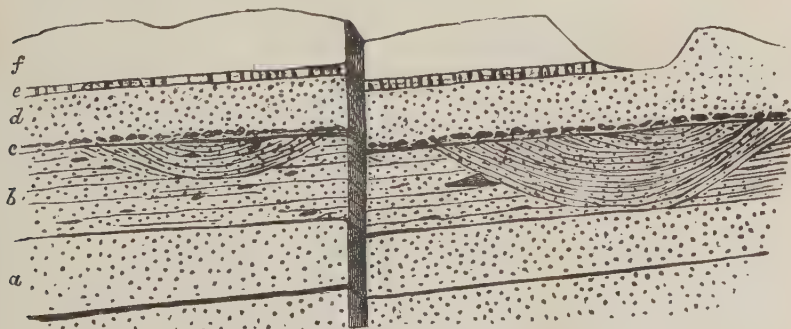


Fig. 3. Sand-pit near Brearton.

- | | |
|--|--|
| <i>a.</i> Red sandstone. | <i>c.</i> Band of fragments, chiefly fuller's earth. |
| <i>b.</i> Red sandstone, much false-bedded, with fragments of red marl and white clay. | <i>d.</i> Red sandstone. |
| | <i>e.</i> White unctuous clay. |
| | <i>f.</i> Red sand. |

The beds dip to the north at an angle of about 10 degrees; they are much broken up and false-bedded, and appear to have been much disturbed during their formation, having somewhat the character of a shore deposit.

The true geological age of this rock may be a matter of dispute, but we prefer to class it with the Permian on account of its peculiar lithological character, although we believe a similar deposit has not been observed anywhere throughout the range of the Permian measures in this part of England.

At the base of the Magnesian Limestone there occasionally occur certain sands which appear to be formed by the decomposition of the limestone itself; they were first noticed by the late Professor Sedgwick in his paper on the Permian rocks of this part of England.

These sands were seen in a pit on the western side of the outlying patch of limestone at New Covert, near Scriven, where the following section was shown:—

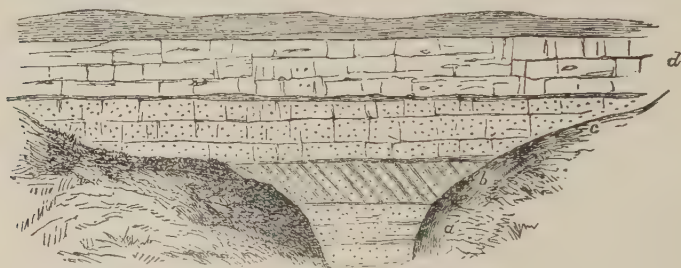


Fig. 4. *Sand-pit at New Covert, near Scriven.*

- a. Fine white sand, with thin yellow clayey bands.
 - b. Sand with hard veins, which form ridges inclined to the plane of bedding.
 - c. Yellow sandy limestone.
 - d. Coarse and rubbly limestone.
- a and b are of a slight pink colour towards the top.*

The bottom of the sand is not reached, so we could not arrive at its thickness, but it cannot be very great, as coarse conglomeratic beds of red grit are seen a short distance to the south, dipping in the direction of the limestone. These sands have been used at Glass Houghton, Pontefract, Harthill, and other places for moulding purposes.

Lower Limestone.—This is the principal rock of the Permian measures, having an average thickness of about 175 feet. It is usually a soft, thick-bedded, yellowish, sandy limestone, but its character varies somewhat in different localities; frequently it is very concretionary, and contains small cavities lined with bitter spar, causing the surface of the rock to weather into curious shapes.

The rock is well exposed in various quarries, but the best sections are to be obtained from the banks of the Nidd, near



Photographed by Goldfrey Bingley, Headingley, Leeds. (Copyright.)

GRIMBOLD CRAG, KNARESBOROUGH. MAGNESIAN LIMESTONE ON MILLSTONE GILT.

Knaresborough, in the railway cutting at Wormald Green, and the banks of the Skell in Studley Park. Some of these sections show that the rock is occasionally much contorted, but this is probably due to local settlement rather than actual disturbance.

The base of the rock, when exposed, is seen to contain fragments of grit and quartz, derived from the underlying Millstone Grit, and has somewhat the character of a conglomerate, being much coarser in texture and harder in substance than the main mass of limestone. This character was well seen in a quarry near Grimbold Crag, at Goldsborough Mill, and other places.

At Markington this conglomerate, which contains waterworn pebbles of limestone and sandstone, is about two or three feet in thickness.

Nodules of impure silicate of lime, which may have been formed round some organic substance, occur in the limestone at Wormald Green.

At Quarry Moor, near Ripon, the rock is traversed by a series of small faults, which give it a peculiar veined structure, the limestone (probably by pressure) being rendered more compact and of a blue colour for some little distance on either side of the lines of fracture.

The upper part of the limestone is frequently much softer and of a more earthy nature, and in the neighbourhood of Farnham and Burton Leonard has been dug in what are called marl-pits, and spread over the land.

The Rev. J. S. Tute has divided this limestone into four horizons in the following order* :—

4. Main mass of limestone.
3. 50 feet of limestone with irregular lumps.
2. Yellowish limestone with *Axinus obscurus*.
1. Lowest beds with *Productus horridus*.

Mr. Tute considers that the lowest beds of Fountains and Knaresborough are not the lowest beds of other places; but whether the earlier beds were ever deposited at these places or have since been denuded is not stated. It, however, shows that considerable irregularity exists at the base of the Permian measures.

Small caves frequently occur in the limestone and are usually filled with clay and stones which have been washed in from above; this is the case with Mother Shipton's Cave at Knaresborough, and also in quarries near Markenfield Hall and in Studley Park. Sometimes the caves form underground passages in which the present streams flow. A good instance is seen in Studley Park, where during the summer the River Skell is entirely swallowed up, and emerges again in the form of a copious spring at a place called Hell Wath, a mile and a half lower down its course.

These caverns or fissures are probably the cause of the "blowing wells" that occur along the outcrop of the Bunter

* *Proc. Yorksh. Geol. Soc.*, vol. viii., p. 218.

Sandstone, and which have been described at some length by Mr. T. Fairley.* Strong currents of air flow from the shafts of these wells during a falling period of the barometer, and inward currents are found when the barometer is rising. This phenomenon has been observed at Ornhams Hall to the south of Boroughbridge, at Solberge to the south of Northallerton, and at Langton to the north of that town, but it doubtless occurs at other places in the district.

The Lower Limestone when exposed in this area is not very fossiliferous, but in a quarry at Aldfield, close to the north-west corner of the map, and also in one at Well rather further north, the following list of fossils was obtained by the Rev. J. S. Tute† —

| | |
|--|--|
| <i>Cythere geinitziana</i> Jones | <i>Schizodus truncatus</i> King |
| <i>Acanthocladia anceps</i> Schloth. | „ <i>rotundatus</i> Brown |
| <i>Fenestella retiformis</i> Schloth. | <i>Bakewellia</i> (<i>Gervillia</i>) <i>antiqua</i> Münst. |
| <i>Productus horridus</i> Sow. | „ <i>ceratophaga</i> Schloth. |
| „ <i>latirostratus</i> Howse | <i>Monotis speluncaria</i> Schloth. |
| <i>Terebratula elongata</i> Schloth. | <i>Solemya</i> sp. |
| <i>Streptorhynchus pelargonatus</i> Schloth. | <i>Pleurophorus costatus</i> Brown |
| <i>Strophalosia lamellosa</i> Geinitz | <i>Leda speluncaria</i> Geinitz |
| <i>Spirifera alata</i> Schloth. | <i>Turbonilla phillipsii</i> Howse |
| <i>Camarophoria schlotheimii</i> von Buch | <i>Turbo helycinus</i> Schloth. |
| | <i>Nautilus frieslebeni</i> Geinitz |

The Middle Marl.—The Middle Marl does not appear to be so thick nor to occupy so large an area as in the map to the south. It consists of red marl and soft red sandstone, which in some sections is excessively like that of Triassic age. There are very few good sections in this rock, the best being those on the banks of the Nidd below Goldsborough Mill and to the west of Bilton Hall; it was formerly visible in the railway-cutting and in the clay pit west of Knaresborough, but these latter are now overgrown and obscured; beyond these places its presence is denoted by the red and clayey nature of the soil. To the north of Knaresborough the country is so thickly covered with Glacial and Post Glacial deposits that there is no evidence of the presence of the Middle Marls, except perhaps near Monkton Mains, where there was formerly an old marl-pit, and where the ground is of a somewhat reddish nature.

These marls in some places are stated to contain large quantities of gypsum, which has been used for making plaster of Paris; but this does not appear to be the case in this district, and the beds of gypsum which occur near here are in higher strata.

The Upper Limestone.—This is, also, not nearly so important a rock as it has been further south, the small patches in the neigh-

* *Proc. Yorksh. Geol. Soc.* vol. vii., pt. iv., p. 409.; also A. C. G. Cameron, *Geol. Mag.* 1880, p. 95.

† *Proc. Yorksh. Geol. Soc.* vol. iv., p. 557, and MS. notes.

bourhood of Goldsborough and Knaresborough being all that occur in the map. At these places it is a thin fissile limestone, easily crumbling away on exposure to the atmosphere, and of scarcely any commercial importance. It is well seen in the railway-cutting west of Knaresborough, resting on red marl, and in quarries at Goldsborough where it is fossiliferous.

The following species from Goldsborough have been determined by Dr. Ivor Thomas :

Mytilus septiter *King*

Schizodus rotundatus (*Brown*)

The Upper Marl has not been observed in this district.

CHAPTER IV.

TRIAS.

Owing to the thick covering of Drift deposits which extends across the centre of the district very little is known as to the general relations of the Trias to the beds that lie below. Practically the Permian and Trias form an unbroken series, and although the former is linked palæontologically with the older rocks, lithologically it is more allied to those above. For this reason it is difficult to separate the marls of one formation from the sandstones of the other. In this region, however, the ground is, as we have said, so obscure that this difficulty is not of much account, as the division between the two can be but merely approximate. Whether the Trias is conformable to the Permian or whether the former overlaps the latter there is no evidence to show.

The New Red Sandstone consists probably of the two divisions of Bunter and Keuper Sandstone and Marls, although owing to the thick covering of superficial deposits it is only the former that is actually seen at the surface, and even that at only comparatively few places.

BUNTER SANDSTONE.

This is a soft, brick-red, thick-bedded sandstone, containing occasionally thin marly partings, and in one locality several veins of opaque white quartz. The best sections of this rock are to be found in the railway-cutting half a mile east of Cattal Station, and at Aldborough; besides which it is exposed near the bank of the river at Hunsingore, in the bank of the river at Broad Oak Farm, at the Keeper's Lodge north of Hunsingore, at Cattal Station, in the road and lane east of Green Hammerton,* at Thorpe Green, at Little Ouseburn, and in a field south of Marton. It is also well seen at several places to the north-east of Ripon just beyond the northern boundary of the map. At Aldborough and Ripon it was formerly used as a building-stone, but these quarries are not now in use.

A curious circumstance connected with this rock is its liability to sink and form depressions and hollows in the surface, from 50 to 100 feet across, and occasionally perpendicular shafts of large size. Several of these pits occur in the northern part of the map near the town of Ripon. At Bishop Monkton one of these sinkings occurred about 40 or 50 years ago, which carried away a stack that was being made at the time; but the most remarkable one which we have seen is just beyond the limits of the

* Farey mentions the occurrence of beds of gypsum at Green Hammerton. *Phil. Mag.* vol. xxxix., p. 106.

map north of the railway station at Ripon; it is a perfectly perpendicular shaft, having a depth of between 60 and 70 feet. The formation of these pits is, probably, due to the washing away of the friable marls and gypsum below the New Red Sandstone.*

KEUPER SANDSTONE AND MARL.

This division of the Trias is not exposed anywhere in the district, and the only evidence of its occurrence is that which can be obtained from boreholes.† There are, however, very few that throw any light on the subject.

Many years ago a borehole was sunk in search of coal at some distance to the north of Alne Station, which penetrated to a depth of 140 yards, the last part being in grey shale and freestone. At Huby Burn Farm, 66 feet of red marl and gypsum were passed through. At the Union Steam Flour Mills at Easingwold, a considerable thickness of marl was met with. At Raskelf Station, 56 feet of marls and gypsum were pierced before reaching the sandstone below. At Spring House, about half a mile to the south, a great thickness of "freestone rock" was met with. Sandstones also were proved in the borings at Borough-bridge, Brafferton, Newton-on-Ouse, Cattal and Kirk Hammerton. From this evidence it appears that the greater part of the Vale of York is composed of Bunter and Keuper Sandstones, and that the Keuper Marl comes on to the north-east near Huby Burn and Raskelf Station.

In the map to the east white and red sandstones with pebbles of quartz and thin marly partings were found at the North Riding Asylum near York, which probably represent the lower part of the Keuper Sandstone. Red and grey marls and thin white sandstones with ripple marks and pseudomorphous crystals of salt are also seen at several places near the banks of the Derwent, and have been found in borings in the map to the east. These apparently are on the same line of strike as the beds which were penetrated at Easingwold, Raskelf and Huby.

RHÆTIC BEDS.

Owing to the large amount of Boulder-clay and gravel that covers the flanks of the hills on the eastern side of the Vale of York few opportunities are afforded of studying the junction between the Keuper Marl and the Lias. The existence of the Rhætic Beds is, however, fully proved by sections that are exposed both to the north and also to the east; so that their outcrop to the west and south-east of Easingwold may be inferred

* For further account of these pits see papers by the Rev. J. S. Tute, *Geol. Mag.* vol. v., p. 178; *Proc. Yorksh. Geol. Soc.*, vol. v., p. 2; A. C. G. Cameron, *Geol. Mag.* dec. ii., vol. vi., p. 575, and vol. vii., p. 95; *Rep. Brit. Assoc.* for 1881, p. 617; *Proc. Yorksh. Geol. Soc.* vol. vii., p. 342; T. Fairley, *Chem. News*, vol. xlv., p. 242; *Proc. Yorksh. Geol. Soc.* vol. vii., p. 409; *Rep. Brit. Assoc.* for 1881, pp. 544 and 601.

† Details of these sections are given in the appendix.

from the general position of the sub-divisions of the Lias which are better seen. The outcrop of the Rhaetic Beds probably enters the map a short distance to the east of Raskelt Station, and runs nearly parallel to the railway until it meets the fault running through the town of Easingwold, by which it is thrown up, and is met with again on the eastern side of the town, where in a field called Paradise Messrs. Tate and Blake mention having found fragments of Rhaetic and Keuper rock in the spoil-heap from a well. From this point the outcrop passes beneath the superficial beds of the flat country, and no indication of the Rhaetic Beds is afforded until we reach the slightly rising ground to the south of Stillington. No evidence has been obtained either as to the thickness or nature of the Rhaetic Beds in this immediate neighbourhood; but in order to give some idea of their character in this district, the following summary, compiled from sections in the country to the north, is interesting:—

| | | Ft. | In. |
|----------------|---|-----|--------------|
| Lias | Brown papery shales with thin wedges of limestone, containing <i>Ostrea liassica</i> , <i>Pleuromya crucecombeia</i> , <i>Protocardia rhaetica</i> . Thin limestone, full of <i>Pleuromya</i> . | 25 | 0 |
| | Paper shales, becoming more argillaceous towards the base. Flattened shells or impressions of the same <i>Pleuromya</i> and <i>Cardium</i> , apparently rather dwarfed. | 15 | 0 |
| | Small band of whitish argillaceous limestone, about 3 in. thick; no fossils seen White shales, no fossils seen. | 10 | 0 |
| Rhaetic Beds - | Black, crisp, pyritous shales, with flattened <i>Pteria contorta</i> , about 8 ft. Close-grained, white siliceous bed, <i>Protocardia rhaetica</i> , " <i>Isodonta Ewaldi</i> ," fragments of Crinoid stems; about 3 in. | | |
| | Black, crisp shales, <i>Pteria contorta</i> very abundant; about 7 ft. | 17 | 0 |
| | Hard, dark, laminated shale, with fish scales and <i>Pteria contorta</i> resting on close-grained siliceous bed, very full of " <i>Isodonta Ewaldi</i> ." The whole is about 9 in. thick, and probably represents the "Bone bed." Dark shales, 1 ft. 2 in. | | |
| Keuper Marl - | Tea-green marl - | - | - about 15 0 |

CHAPTER V.

LIAS.

Lower Lias.—The Lower Lias is but little better exposed than the Keuper and Rhaetic beds below, although there are some slight indications of these shales in the neighbourhood of Easingwold; while fragments of the *Pleuromya* limestones are scattered over the fields near Raskelf.

It is, however, only from wells and other artificial excavations that evidence of these beds can be obtained.

Messrs. Tate and Blake* record the following fossils, which they assign to the lower part of the Jamesoni Zone, from a drain in the lower part of Easingwold:—*Cardium oxynoti*; *Pleuromya* sp., *Belemnites araris*, *Rhynchonella variabilis*, *Cucullæa münsteri*, *Arca* sp., *Ostrea* sp., *Chemnitzia blainvillei*.

Middle Lias.—In the neighbourhood of Easingwold the Middle Lias is seen in a few obscure sections, chiefly in field-drains and roadside ditches. The sandstones in the lower portion (Margari-tatus-beds) are cut through in a small ravine south of Hanover House, and beds in this part of the series were met with in the boreholes for the Waterworks to the north of Howe Hill. The flaggy limestones with *Protocardia truncata* are also fairly common and much used for footpaths.

The upper part of the formation (Spinatus Zone) is best seen around Howe Hill, near the Workhouse and near Halfway House; it has been dug out of the foundations of houses in the town of Easingwold, but these were not exposed at the time of our survey. As far as could be judged from the very poor sections visible, its lithological character is similar to what it is on the north-east coast in the neighbourhood of Whitby and Staithes, with the exception that the irony portion is not nearly so strongly (if at all) developed; this southern extremity of the Yorkshire Marlstone appearing to consist only of sandy shale with thin sandstones, which latter are frequently calcareous and very fossiliferous.

From a small stream, shown west of Halfway House, near the corner of the map, the following species were obtained:—

| | |
|--------------------------------|-----------------------------|
| Protocardia truncata (J. de C. | Modiola sp. |
| Sow). | Pteria (Oxytoma) inæqualvis |
| Rhynchonella tetrahedra (J. | (J. Sow). |
| Sow). | |
| Rhynchonella rimosa (v. Buch). | |

In hard shale, a little further on, *Inoceramus dubius* was found.

* Tate and Blake. "The Yorkshire Lias," p. 85.

The ironstone of Cleveland does not appear to be of any importance in this neighbourhood, although the chalybeate springs which rise in the alluvium at the foot of the town would intimate that these strata still contain a considerable amount of that mineral ; it is probable that its place is taken by less ferruginous beds, for the thickness of the strata between the Upper Lias of Crayke and the base of the sections at Easingwold cannot be much less than 130 feet, which is fully equal to that of the corresponding beds on the coast.

Messrs. Tate and Blake state that 2 feet or more of ironstone was met with in a well at the Workhouse, and that it was likewise reached in a boring for coal near Haverthwaites House, where the rock has a blue oolitic appearance, and contains *Rhynchonella tetrahedra*.

Upper Lias.—Two small outliers of the Upper Lias shale occur on the north side of the town of Easingwold, but no sections were observed in them. On the south side of the fault a narrow strip of Upper Lias is found at a higher level at Mount Pleasant, where the lower part of the shales with *Inoceramus dubius* was seen at the side of the road leading to Easingwold. On the north side they are again thrown up by a cross fault, and crop out around the conspicuous hill upon which Crayke Castle stands.

The thickness of the Upper Lias at this point is about 80 feet ; it forms the steep banks below the Castle, and is exposed at the side of the road.

There are indications that the zones of *Dactylioceras annulatum*, *Harpoceras serpentinum* and *Hildoceras bifrons* are distinguishable in this neighbourhood, but there are no sections that call for particular notice.*

* Compare Tate and Blake, "The Yorkshire Lias," pp. 171, 176, 184.

CHAPTER VI.

SUPERFICIAL DEPOSITS.

GLACIAL BEDS.

The district described in this memoir comprises a considerable portion of the large central valley of Yorkshire, and in order to give a clear account of the Drift it will be necessary to include a somewhat larger part of this valley than that within the area of the map.

Throughout the central part of the Vale of York the Triassic rocks are buried beneath a thick covering of Boulder-clay and gravel, varying from about 50 feet to 100 feet in thickness, which gradually ascends the lower flanks of the rising ground on either side. This Drift is sometimes more or less stratified; but a large proportion is piled up in hummocky ridges, the longer axes of which are ranged in a N. and N.W. direction. This is particularly noticeable along that part of the Vale of York which comes within the present district. On this side of the valley the Drift is of two distinct characters, the one containing only fragments derived from the more immediate neighbourhood, while the other includes a great number of rocks that have come from a distance.

The former of these, which appears to be quite a local deposit, occurs in the south-west corner of the map. It contains chiefly fragments and pebbles of rocks that occur *in situ* at no great distance.

Pebbles of Carboniferous Limestone, which form so large a percentage of the Drift next to be described, are almost if not entirely absent. This deposit, which is not of great thickness, is bounded on its eastern side by a sharply defined line formed in a general way by the valleys of the Crimple and the Nidd, as far as Ripley, and from thence northwards by the narrow gorge in which Cayton Gill flows.

East of this line a marked change occurs in the nature of the Drift. It is a much more important deposit than that just mentioned, and has a greater thickness and a more extended range. It contains large numbers of erratic blocks derived from a distance, and is at once distinguished from that to the west by the abundance of Carboniferous Limestone pebbles it contains. This Drift, which is the ordinary Boulder-clay of the country, covers nearly the whole of the area east of the line through Ripley, mentioned above, the solid rock appearing only in a few places where it has been exposed by denudation. It is a portion of that vast accumulation which extends from the county of Durham through the great central valley of Yorkshire. It is confined entirely to this valley and the low hills on its flanks, the

more lofty ranges of the Cleveland and the Hambleton Hills and the Chalk Wolds being entirely free from it. Throughout this region it maintains its usual character of a stiff clay having a dark-blue colour when unweathered; and containing rounded and subangular pebbles and boulders of rock, principally derived from the sandstones and limestone of Carboniferous age as well as of the Oolite and Lias, with a large proportion of granite and igneous rocks, and occasionally a few flints.

Large boulders washed out of these Glacial beds or deposited on their surface have been observed at several places throughout the map; the largest we have seen is a block of Carboniferous Limestone in the bed of the river Skell, near Bishopton Mills, Ripon; this block measures 9 feet in length by $5\frac{1}{2}$ feet in breadth, with a height of $3\frac{1}{2}$ feet above the surface of the water; but how far it extended below that level was not determined.

The erratic blocks scattered over this valley are evidently very numerous, as will be seen from the following list showing their distribution, which has been drawn up from the notes of different observers in this part of the district.*

Carboniferous Limestone and Sandstone are fairly universal, but special boulders have been noted at Arkendale, Baldersby, Bilborough, Brompton, Carlton Bank, Claro, Coxwold, Harrogate, High Catton, Holtby, Hutton Moor, Kilburn, Kirklington, North Stainley, Sinderby, Stillington, Studley Park, Topcliffe, York, Osmotherley.

Shap Granite at Alne, Baldersby, Bilborough, Claro Hill, Cundall, Holtby, Kilburn, Lindrich, Marton-cum-Grafton, Stillington, Tholthorpe, Thornton-le-Beans, York, Osmotherley.

Lake District Volcanic Rocks at Ainthorpe, Coxwold, High Catton, Holtby, Thirsk, Osmotherley.

Other volcanic rocks at Aldfield, Bilborough, Brompton, Carlton Bank, Flaxby, Holtby, Hutton Moor, Kilburn, Kirklington, North Otterington, Thirsk, Whorlton, Wighill, Osmotherley.

The western edge of this Drift is sharply marked by a line running from the west side of How Hill along Cayton Gill, by the Nidd at Ripley, to the Crimble near Plumpton, which evidently indicates the extreme limit in this direction of the great glacier that came down the Vale of York. The Drift in this part of its course, that is between Thirsk and York, contains a much larger amount of sand and gravel than it does further north; in fact, the greater proportion of the superficial deposits occurring in this map to the east of the Nidd are of this nature. These gravels are banked up over the rising ground of the Trias and Magnesian Limestone, and form a very striking feature in this part of the country. They occur in a series of more or less continuous ridges running in a S.E. by S. direction roughly parallel with one another and with the general trend of the ground on the west side of the vale. A curious feature connected with these ridges along the western

* Most of these are from the lists in the British Association Reports for 1887, 1888, 1889, 1892, 1893, 1895, 1896, 1897, 1899, 1901, 1902, 1903, 1904.

side is that, while they slope away gradually to the west, they almost invariably present a steep bank to the east.

These gravels as shown by Professor Kendall, have evidently been piled up along the margin of the great glacier which came down the Vale of York, and at different periods deposited its terminal moraines at York and Eserick.* By the accumulation of these deposits the water coming off the western uplands was ponded back, and forced to seek new channels further to the south. These abandoned channels and the numerous instances of the diversion of the river courses are a very remarkable feature of the district, and will be referred to again later on in treating of the physical structure of the country.†

POST-GLACIAL BEDS.

Much of the sand and gravel forming the higher elevations in the great plain of the Vale of York should probably be classed with the Glacial beds, although they have undoubtedly been much rearranged in Post-glacial times, and it is difficult to separate them from the sands of later date. The same may be said of the laminated clay; this in general character much resembles that of the Tees Valley to the north, which has been considered to be of Glacial age. In this district, however, it joins on without any apparent division to the warp beds of the Humber, which are certainly of quite recent date.

Warp and Lacustrine Clay, Sand and Gravel.—These deposits cover nearly the whole of the surface in the eastern part of the map, forming a portion of the great plain which stretches by York and Selby to the Humber. The whole of this ground, with the exception of Ten Mile Hill, near Tholthorpe, is below the 100 ft. contour line, and if the superficial beds were removed would in most cases be below sea-level. It forms a plain of flat clay land interspersed here and there with low, undulating hills of sand and gravel. These sands and gravels are generally well stratified and without striations.

The warp deposits consist of three divisions:—An upper clay splitting up into little cubical pieces, and often containing small phosphatic nodules (race); a few feet of sand and loam in lenticular masses; and a lower unctuous clay disposed in fine laminae. At Park House, near Newton, there is a bed of sand below the laminated clay; but it is usual to find this clay in most of the brickyards, where the only good sections are obtained, at the base. These beds have a thickness in some places of 70 feet or more, but it is generally not so much as this.

The lower of these clays only is used for the better kinds of work, such as chimney pots, tiles and best bricks; the upper clay makes only an inferior kind of brick.

* *Proc. Yorksh. Geol. Soc.*, vol. xii., p. 306; vol. xiii., pp. 15 and 89.

† See page, 31.

Deposits of peat and clay occur at several places throughout the centre of the map; they occupy depressions in the Boulder-clay, and form flat clay land, not unlike the warp country, but on a much smaller scale. In some cases these appear to be due to subsidence over the Permo-Triassic boundary from the washing away of the marl and gypsum near the junction of these formations, as noticed in the chapter on the Trias; but in others, as at Farnham and Goldsborough, they are more probably the result of the blocking-up of old stream courses in Glacial times.

The principal areas of this clay are those which occur west of Farnham, north of Staveley, on Arkendale Moor, on Goldsborough Moor, south of Great Ouseburn, west of Cattal Station, and near Hunsingore; but there are a large number of smaller patches throughout the district, a great many of which have been obliterated since the country has been brought under cultivation. Previous to the country being enclosed many of these were mere swamps, but now they are most of them drained by means of deep dykes, and rendered comparatively dry and fit for agricultural purposes.

The following section in beds of this age was opened in 1868, previous to the commencement of our survey of this district; for the particulars of this we are indebted to the Rev. J. S. Tute, of Markington:—

Fresh-water deposit near Hollin Hall, Ripon.

| | |
|--|--------------|
| 1. Soil - - - - - | } 18 inches. |
| 2. Yellow clay - - - - - | |
| 3. Peat - - - - - | 3 " |
| 4. Freshwater shells (all of recent species) - - - | 1 " |
| 5. Marl - - - - - | 6 " |
| 6. Bluish clay. | |

Mammalian Gravels.—In the Vale of York, more especially about Overton, are certain sands and gravels in which, from time to time, bones of mammalia have been found. They do not occupy any great extent of surface, but may perhaps extend below the alluvial covering of this great valley. The gravels also at Tollerton, Aldwark, Tholthorpe, and Brafferton are probably of this date, but without further evidence it would be impossible to determine their real age.

The gravels at Overton were formerly extensively used for repairing the roads, and were excavated to a considerable depth. About the year 1818 Mr. James Cook, of York, discovered in these gravels, at a depth of 30 ft., the following mammalian remains:—

- Elephas primigenius (molar tooth).
- " (tusk).
- Rhinoceros tichorhinus (molar tooth).
- " (portion of tibia).
- Stag " (portion of palmated horn).
- " (portion of rib).
- Reindeer (part of an antler).
- Horse (coronary bone).

Also bones of tiger, elk, and bird.

The bones were found in dark-red clay below 4 feet of rolled gravel, the upper part of the section being chiefly pale-red sand.

Teeth of Mammoth have also been found at Grafton in 1876, near Ripley,* at Norwood in the Washburn valley, and other places. Deers' horns are recorded from Cowthorpe,† Timble Gill near Fewston and other places in the neighbourhood.

Alluvium and River Terraces.—Along the banks of the Nidd, within four miles of Knaresborough, on either side, and also on the banks of the Skell, near Ripon, there occur several terraces of gravel on both sides of the stream, which were formed when the river flowed at a higher level. The most remarkable of these terraces is that at Ripley, which almost surrounds the boss of Magnesian Limestone standing up at Nidd Rock.

It is a curious fact connected with these terraces that they all occur just above the 100 ft. contour, which is the maximum elevation of the warp clay; and it would appear from this that they were deposited about the same time, and when the lower portions of the Ure and Nidd were under water as far as Ripon and Walshford Bridge respectively, and the warp clay was being deposited in these regions.

On either side of the streams, both great and small, there is a modern alluvium—the flat of the present river. This alluvium, which forms the largest spreads near the lower part of the Swale and near Ripon, is about 25 feet below the warp flat.

* *Proc. Yorksh. Geol. Soc.*, vol. xii., p. 246.

† *Phil. Trans.*, vol. xlv., p. 124.

CHAPTER VII.

PHYSICAL STRUCTURE.

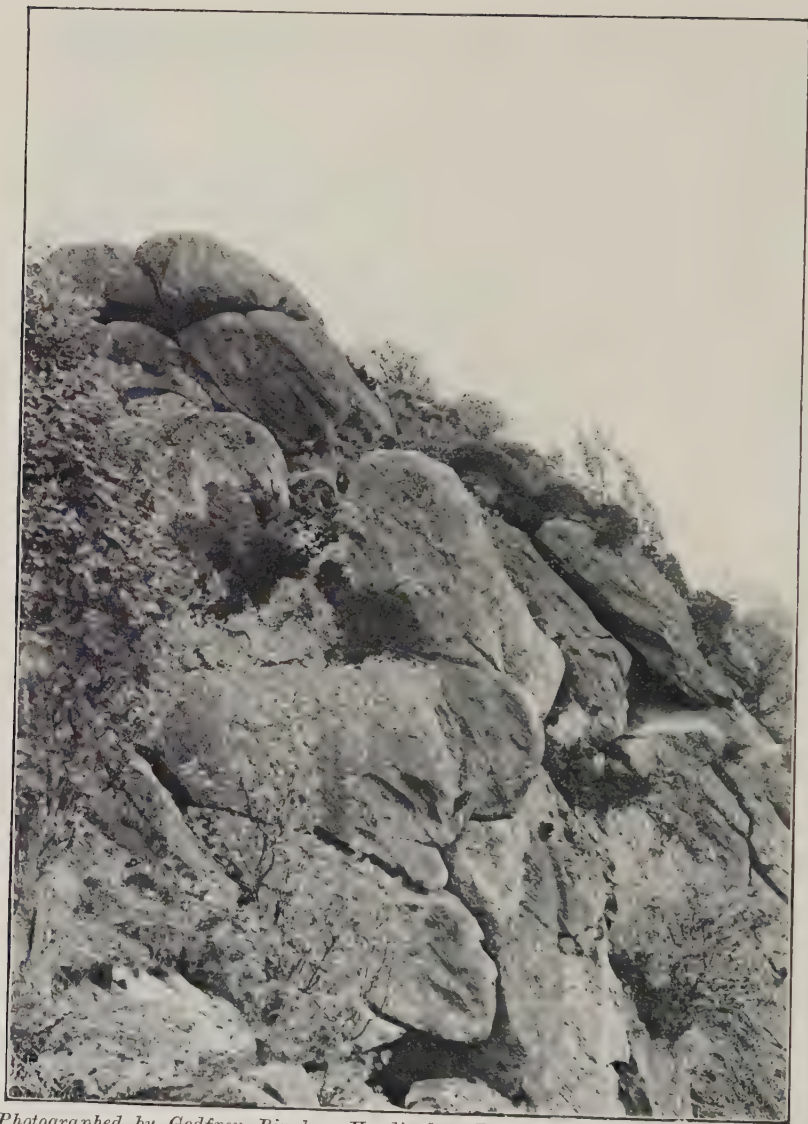
On glancing at the map, the first thing that strikes the eye is that all the faults except one are towards the south-west quarter. This arises from two causes: firstly, it is only on this side that the older Carboniferous rocks with their numerous dislocations, and especially the remarkable disturbance at Harrogate, come to the surface; and, secondly, because all the country comprised in the northern and eastern part of the map is obscured by the sands, clays, and gravels of Glacial and Post-glacial times.

At Harrogate the most interesting portion of the physical geology may be said to be centred; for it is here that we get the eastern end of that great anticline which stretches across the country from Clitheroe in Lancashire to the north of Pendle Hill and Skipton. The direction of this anticline, in the country to the west, is more or less easterly; but within a few miles of Harrogate it suddenly bends towards the north, and in this district has its axis running nearly in a north-east and south-west direction. As it is along this line that the greatest amount of denudation has taken place, and the lowest beds are exposed to view, we cannot do better than commence our detailed account of the position of the rocks by first of all tracing this axis of disturbance.

But before going any further it will be necessary to mention the fault which forms the northern boundary between the Millstone Grit and the Harrogate Roadstone Series. This fault, which we will call the great anticlinal fault, has a downthrow to the north; it runs in a north-easterly direction, a short distance north of Shaw Green, along the northern side of Harlow Hill and Harrogate, to the Magnesian Limestone near Bilton.

In a small stream, to the south-west of Shaw Green, the Harlow Hill Sandstone is seen first of all dipping to the west at an angle of about 35 degrees, and a little lower down rolling over and dipping at a very high angle to the south-east; on either side of this the encriental roadstone of Harrogate crops out, dipping to the north and south at angles varying from 20 to 45 degrees. From these dips it is seen that Shaw Green stands upon an anticlinal axis. Now if we follow out the course of these two rocks with the shales both above and below them we shall have described the whole of this series of rocks as far as they are exposed in this part of the country.

To the east of Shaw Green the lower shales crop up and divide the Harlow Hill Sandstone into two portions, the northern of which striking across the low country is lost against the fault near Harlow Carr, while the southern branch (which is much better seen) crosses the country by How Hill and Harlow Hill to the Bogs Field at Low Harrogate.



Photographed by Godfrey Bingley, Headingley, Leeds.

BIRK CRAGS, NEAR HARROGATE. KINDER SCOUT GRIT
DIPPING 43° TO THE N.W.

The roadstone, which on the north of the anticline is only seen at one quarry near Shaw Green, to the south has a somewhat extended range, and is well exhibited at several places north of the Crimble Beck as far as Beckwith House, and again near the Cold Bath Road, Low Harrogate, at which latter place it dips to the south-east at about 20 degrees, but soon rolls over, and on the opposite side of the little valley which comes down from the Bogs Field it dips north-west at about 60 degrees into the great anticlinal fault. Between Beckwith House and Cold Bath Road its course is somewhat obscure, and can only be traced by means of the fragments in the fields. A great thickness of shale separates these measures from the lower beds of the Millstone Grit.

The three lowest members of this series, that is the Kinder Scout group, are those which are most affected by the peculiar structure of Harrogate. These coarse and massive grits form, as it were, walls on either side of the anticline, and afford a key to the whole structure of the neighbourhood. To the north of the great anticlinal fault the lowest of these beds is thrown down by that fault, and does not appear at the surface; but to the south the whole series is well exposed in several places, more particularly in the railway cutting and along the hill-side north of Pannal. The uppermost of these beds, which dips towards the Crimble Valley at an angle of from 15 to 20 degrees, forms a well marked and almost unbroken ridge from Almes (Alms) Cliff in the map to the south, through Pannal as far as Starbeck, where it disappears below the Permian rocks.

On the northern side of the anticline the total thickness of this group of rocks does not appear to be so great; but the uppermost member, which dips to the north-west at about 43 degrees, again forms a marked feature to the south of Oak Beck along the line of the well-known Birk Crag.

These rocks, at their eastern end, bend round towards the fault and at the same time the dip is considerably less, for at Starbeck the top bed of Kinder Scout Grit crops out dipping east at 4 degrees; from this it appears that the anticline of Harrogate dies out to the east, and that there is no great anticlinal ridge of Carboniferous Rocks below the Permian and Trias in this part of the country.

The Third Grits are not nearly so much disturbed as those we have been describing. To the south of Harrogate the lower or Follifoot beds form the escarpment south of the Crimble, known as Follifoot Moor, where they have a dip to south-east of about 8 degrees. To the north of this they are thrown down by a small east and west fault running through Rudfarlington, but again appear in the valley at Crimble Farm and Rudfarlington Wood, a little north of which they are lost below the unconformable Permian rocks, but again crop up in the bed of the river Nidd above Knaresborough. The Cayton Gill beds, which are not very strikingly exhibited in this part of the country, next succeed and form a band running across the Prospect Tunnel and Rudding Park. To the south-east of this the thick beds of Plumpton Grit

crop out, spreading over the country in the direction of Spofforth and Plumpton with a few inlying patches cropping up from below the Permian at Birkham Wood, Goldsborough Mill and Knaresborough.

On the northern side of the Harrogate anticline these beds roll over, and on the north side of Oak Beck the Follifoot beds strike north-east across Killinghall Moor and Harrogate End to the Magnesian Limestone at Bilton—the Cayton Gill beds capping the hill at Saltergate. At Killinghall there is a large spread of Plumpton Grit, which, extending eastwards across the Nidd as far as the Limestone near Scriven, is bounded on the west by small faults which again throw up the Lower Third Grit beds on both sides of the river above Ripley Station.

On Scarah Moor there is a second anticline, having its axis parallel to that at Harrogate, which brings up the Follifoot and Cayton Gill beds for a short distance, but they are soon cut off by an east and west fault a little north of Thornton Moor House, and only appear again in the low ground west of Haddockstones Grange and in the valley west of Fountains Abbey.

The Plumpton Grit, north of the river Nidd, occupies a considerable tract of country ranging north-west from Scriven to the banks of the Skell at Fountains. Throughout this district it is much obscured by Boulder-clay and gravel, but its outcrop to the north and west of Ripley is clearly marked.

The Permian beds, which have a general north-easterly dip of from 2 to 3 degrees, occupy, as we have said before, a band of country running diagonally across the western half of the map. They form a well-marked line capping the grit escarpment from Spofforth to Plumpton, where they are thrown down by an east and west fault, a good section of which was seen in the bank of the river Nidd, and also in the roadside at the same place. The Magnesian Limestone is again seen near Rudfarlington, but a little to the north of this it appears either to thin out or to have been denuded away previous to the deposition of the marl; as in a quarry at Arlington House, red marl rests directly on Millstone Grit rocks, and on the right bank of the Nidd, above Knaresborough High Bridge, a band of limestone appears below the marl, but is too thin to be delineated on the map. About Bilton the limestone again appears to thicken, and it occurs in that neighbourhood in a series of outliers along a north-east and south-west line at Bilton and Scriven. From Knaresborough northwards, the limestone forms a well-marked escarpment by Farnham and South Stainley as far as Markington; from this point northwards its exact base is obscured by a thick deposit of gravel. At Barsneb, South Stainley, Nidd Hall, and Nidd Rock are outlying patches of this limestone; at the first and last of these places the rock is exposed in quarries, but at South Stainley the only evidence was the fragments in the fields, and at Nidd Hall that derived from a well. At Nidd Rock the limestone appears to be thrown in by a fault, for on the south side of the river the massive red grit of Plumpton forms a cliff of

50 feet or more, and in the bed of the river these beds are seen dipping to the north at a high angle. On the north side of the river nothing but limestone is to be seen until we come to the next railway-cutting to the east, where soft yellow limestone reposes on red sandstone and shales; whether the limestone is here faulted down or was deposited against an old cliff of Millstone Grit there is not sufficient evidence to prove, the river having obliterated the junction.

Although the evidence at this place seems to be in favour of a fault, or at least of an unconformable junction, it is just possible that the apparent irregularity may be caused by a rapid change of dip; for while in the bed of the river, on the southern side, the Millstone Grit is seen to be lying nearly flat, on the northern bank the same beds are seen to dip rapidly to the north and east, and the junction may be conformable and unfaulted as in the diagram given below.



Fig. 5. *Section across the Nidd at Nidd Rock.*

1. Millstone Grit.
2. Magnesian Limestone.

In the neighbourhood of Goldsborough there are two or three small faults which more or less affect the Permian measures. The principal evidence for these is exposed along the banks of the river, but to the east they soon become obscured by a thick covering of Boulder-clay.



Fig. 6. *Fault at Goldsborough Mill.* Drawn by J. C. Ward.

- | | |
|---|------------|
| <ol style="list-style-type: none"> a. Red grit. (Millstone Grit.) b. Soft yellow limestone, with small pebbles from the grit in its lower part, and occasional thin lines of similar pebbles. c. Yellow earthy thin-bedded limestone (above footpath). d. Earthy limestone. e. Thin-bedded limestone. f. Thicker earthy limestone. g. Red marl, only a few feet thick, there being a quarry in yellow limestone just behind. | } Permian. |
|---|------------|

The Triassic beds, which really cover half the superficial area of the map, are, on account of the extensive alluvial deposits of

the Vale of York, represented as occupying only a space equal in extent to that of the Permian.

This portion, coloured on the map as Trias, is occupied entirely by the Bunter Sandstone, which has been seen at the few places mentioned above. It is a gently undulating district, thickly covered with Boulder-clay and gravel, and forming no good geological boundaries. On the western side its base can be only traced approximately by the aid of wells, and on the eastern side it gradually sinks below the great plain of central Yorkshire leaving no clue, except from a few boreholes, as to the nature of the strata between this and Easingwold, where the fossiliferous beds of the Lias begin to rise on the flanks of the Oolitic outlier at Crayke.

Thus all the faults, with the exception of those near Goldsborough, appear to be more or less connected, and to owe their origin to the great pre-Permian disturbance in the western part of the map; for at Harrogate all the faults of any note are more or less parallel to that axis, and this is again the case on Scarah Moor; but in the intervening area between these to the west of Ripley, where the beds are somewhat arched along an axis striking north and south, the faults also range in that direction.

From the foregoing remarks it is seen that the area included in the map may be divided into three districts, each having an aspect peculiar to itself. In the south-west corner the Millstone Grit rocks, when not obscured by Drift, form the usual bold features and deep valleys peculiar to this formation, although not in so marked a degree as these rocks do further to the west, the effect being somewhat lessened by the high angles at which the rocks lie near Harrogate. The series of rocks beneath the Millstone Grit attain a height of 600 feet above the sea at Harlow Hill, but the Millstone Grit rocks themselves do not rise to more than an average height of 400 feet.

The Permian and Triassic rocks, or, more properly speaking, the Magnesian Limestone and Bunter Sandstone, as it is only these which really affect the physical character of the country, form the central district. These rocks, which together occupy an area equal to more than half the map, usually form a good escarpment to the west, while to the east they gradually slope away below the alluvial covering of the Vale of York. This district, which is somewhat elevated, and in the extreme north, near Fountains Abbey, where it is thickly covered with Drift, attains a height of nearly 600 feet, does not rise to more than 200 feet above the sea in the southern portion of the map.

Almost the entire surface of these rocks is covered by gravels and sands of Glacial and Post-glacial age, which have very much altered its physical aspect; so that instead of a continuous and uniform slope to the east, we get a series of mounds and hills which form a generally undulating and park-like country.

To the east of this is the great alluvial plain stretching north from York. This district, which, when viewed from the higher

ground on either side, appears to be a dead-flat, is in reality somewhat undulating. The Warp Clay, which covers the larger part of this ground, forms an almost perfectly level plain, having an average height of about 50 feet above the present sea-level, while the sand and gravel with which it is associated forms gently undulating ground, attaining at Tholthorpe a height of 75 feet above this plain.

Before closing this portion of our subject it will be as well to say a few words about the general denudation of the valleys and the courses in which the present rivers flow.

The general drainage of the country is to the east, as might be naturally inferred from the dip of the rocks; but it is curious to observe that all the rivers to the west of the Magnesian Limestone escarpment have cut their way through that formation, and form a series of steep valleys or gorges, which contain some of the prettiest scenery in the district; thus the Skell at Studley, the Beck at South Stainley, the Nidd at Knaresborough, the Crimple at Spofforth, and even the little stream near Walkingham Hall have each a separate channel through the Permian escarpment.

These valleys however are not in many cases the original courses of the streams, which have been diverted and forced into new channels by the accumulation of Glacial detritus. Thus the Laver, which flows to the north of Grantley and Aldfield, at one time turned south along the narrow valley between these places now occupied by the Horsley Dike, and joined the Skell below Grantley Hall.

The Skell appears to have twice altered its course. In its upper part it once occupied the streamless defile east of Sawley Hall known as the Dean, and joining the Hebden Beck flowed southwards. Lower down, after traversing the grounds of Fountains Abbey, it flowed north and east across Studley Park; this valley becoming blocked by Glacial beds, it cut the present picturesque channel through the Magnesian Limestone in Mackershaw Woods to the east of the great lake.

Another instance is the case of the Markington Beck. This stream coming down from Haddockstones now flows eastwards by Markington and South Stainley into the Ure at Newby; this does not appear to have been its original course, for at Dole Bank and thence southwards to Ripley, there is a well-marked gorge, which is in some places fully as wide and deep as that of the Nidd near Knaresborough, and considerably larger than that in which the present stream flows. This valley is now drained only by the diminutive stream of Cayton Gill, which joins the Nidd below Ripley; but it is evident that a much larger stream must originally have cut the streamless defile at Dole Bank, where it is interesting to observe the abrupt turn the Markington Beck makes to avoid this valley.

The River Nidd furnishes a further instance of the alteration of the stream courses. This river, which now flows through the evidently Post-glacial gorge past Bilton and Knaresborough,

originally passed to the north of Nidd Rock and followed the more open valley by Nidd Hall and Brearton, to the gap in the Magnesium Limestone at Staveley.

Thus, all these streams have been diverted from their original channels, which are now marked by the almost streamless defiles at Grantley, Sawley, and Dole Bank; and which appears to have been the course of a southward flowing stream that intercepted all the drainage coming from the west.

CHAPTER VIII.

ECONOMIC GEOLOGY.

Reference to the economic value of the rocks and minerals has been incidentally made in the previous pages. A further account is here given with special regard to these points.

Mineral Waters.—Of all the products derived from the rocks in this district the most important are the mineral waters to which the town of Harrogate owes its origin and success. These springs are confined almost entirely to the south-west corner of the map, although mineral springs are found at a few other places in the neighbourhood, and in one or two instances have also been reached by borings. They are situated on the axes of the great folds which have taken place in the older rocks, or in close proximity to these anticlines, and there is but little doubt that they owe their origin to this cause. The history and general occurrence of the Harrogate waters is treated of in the next chapter, so that it is not necessary to go further into the subject here.* But besides the eighty or so springs which rise from the Harrogate anticline there are a few other mineral springs rising in the neighbourhood which may be briefly noticed.

A sulphur spring issues at Aldfield, in the valley of the Skell above Fountains Abbey on the axis of an anticline parallel to that at Harrogate. This spring, being somewhat difficult of access, has not been much noted. An old analysis of this water was made by Dr. W. Brunton in 1806, which is quoted by Dr G. Cayley. †

| | Grains per gallon. | | | |
|-----------------------|--------------------|---|---|-------|
| Carbonate of lime | - | - | - | 12·5 |
| Carbonate of magnesia | - | - | - | 3·5 |
| Sulphate of magnesia | - | - | - | 5·0 |
| Muriate of magnesia | - | - | - | 96·0 |
| Muriate of soda | - | - | - | 208 0 |

| | Cubic Inches. | | | |
|-----------------------|---------------|---|---|----|
| Carbonic acid gas | - | - | - | 6 |
| Azotic gas | - | - | - | 4 |
| Sulphuretted hydrogen | - | - | - | 21 |

Temperature 54° F.

* See page 42.

† Dr. G. Cayley, "Synoptical Tables," 1809.

The following more modern analysis of this water has been supplied by the Manager of the Spa Hydro at Ripon.

Extract from the Report of Professor (now Sir Thomas) Stevenson, Guy's Hospital, London.

Specific gravity of the water at 60° F. 1·0032.

Temperature of spring 53° F. (air temp. 70° F.).

| | In grains per gallon. | In parts per 100,000. |
|-----------------------------|--------------------------|--------------------------|
| Strontium Sulphate - - - | 0·76 | 1·09 |
| Calcium Sulphate - - - | 22·10 | 31·57 |
| Calcium Carbonate - - - | 9·84 | 14·06 |
| Calcium Chloride - - - | 6·48 | 9·26 |
| Magnesium Chloride - - - | 30·54 | 43·62 |
| Magnesium Bromide - - - | 0·13 | 0·19 |
| Magnesium Iodide - - - | Traces | Traces |
| Potassium Chloride - - - | 4·37 | 6·24 |
| Sodium Sulphate - - - | 5·51 | 7·73 |
| Sodium Chloride - - - | 195·27 | 278·95 |
| Lithium Chloride - - - | 0·87 | 1·24 |
| Ferrous Phosphate - - - | 0·06 | 0·09 |
| Ammonium Carbonate - - - | 0·23 | 0·33 |
| Silica - - - - - | 1·10 | 1·57 |
| | <hr/> | <hr/> |
| | 277·16 | 395·94 |
| Sulphuretted Hydrogen - - - | 0·77 | 1·10 |

Or in cubic inches per gallon at 60° F. 2·1.

N.B.—The Sulphuretted Hydrogen was all, or nearly all, in the free or uncombined state.

Examination for Organic Purity.

| | In grains per gallon. | In parts per 100,000. |
|--------------------------|--------------------------|--------------------------|
| Saline Ammonia - - - | 0·081 | 0·1157 |
| Albuminoid Ammonia - - - | 0·001 | 0·0014 |

A spring of considerable celebrity is the Dropping well at Knaresborough. This, which is an ordinary petrifying spring, has drawn much attention from the picturesque manner in which it spreads over a limestone crag, covering it with a thick tufaceous deposit. This spring, which has been mentioned or described by many authors writing on the district, issues from the Magnesian Limestone, but whether the water is thrown out from the junction of this limestone with the Carboniferous rocks below is uncertain*. The following analysis of this water is given by B. A. Burrell:—†

* A view of this spring, published by J. Smith in 1747, is in the British Museum Library, K. 44 (38,39).

† *Journ. Chem. Soc.* 1896, vol. lxi., p. 536. *Proc. Yorksh. Geol. Soc.* 1897, vol. xiii., pt. ii. p. 141.



Photographed by Godfrey Bingley, Headingley, Leeds.

THE DROPPING WELL, KNARESBOROUGH. CRAG OF MAGNESIAN
LIMESTONE COVERED WITH TUFFA.

Dissolved Saline Constituents in grains per gallon:—

| | | | | | |
|---------------------|---|---|---|---|---------|
| Calcium Sulphate | - | - | - | - | 114.373 |
| Calcium Carbonate | - | - | - | - | 25.480 |
| Calcium Silicate | - | - | - | - | 1.442 |
| Strontium Sulphate | - | - | - | - | 0.672 |
| Magnesium Sulphate | - | - | - | - | 17.003 |
| Ferrous Carbonate | - | - | - | - | 0.154 |
| Manganese Carbonate | - | - | - | - | 0.084 |
| Sodium Chloride | - | - | - | - | 2.765 |
| Potassium Chloride | - | - | - | - | 0.462 |
| Alumina | - | - | - | - | trace |
| Phosphoric Acid | - | - | - | - | trace |

162.435

Fixed residue by evaporation dried at 170 to 180° C. - 162.324.

Specific gravity at 15.5° C. - - - - - 1.0024.

Gases dissolved by the water in cubic inches per gallon, and measured at 15.5° C., and 760 m.m.

| | | | | | |
|-----------------|---|---|---|---|------|
| Carbon Di-oxide | - | - | - | - | 4.74 |
| Oxygen | - | - | - | - | 1.29 |
| Nitrogen | - | - | - | - | 5.02 |

11.05

Another spring which has been alluded to by many of the older writers is that of St. Mungo. This does not appear, however, to be a spring of very marked mineral character, and is said to owe its reputation chiefly to its great coldness. There is some confusion as to the situation of this spring. There is little doubt, however, that it is the spring near Copgrove, which is marked on the Ordnance map, but many of the older writers place it about half a mile west of the Old Sulphur Well.*

Building Stone.—The best building stone of the district is undoubtedly the Millstone Grit, which has been quarried at numerous places along the western side of the map. The Magnesian Limestone also makes a good building stone, but its quality in this district does not appear to equal what it is further south, where it has been used in many important buildings, the Houses of Parliament, Westminster Hall, York Minster, Beverley Minster and many other structures being built of stone procured

* St. Mungo's (or Mongah's) well was visited by Thoresby in 1682; Rev. J. Hunter, "Diary of Thoresby," vol. i., pp. 86, 234, 424. A full account of this well is given by D. H. Atkinson, "Ralph Thoresby the Topographer, his town and times," 1885, p. 114, and add. notes. The earliest description of this spring is by Dr. Clayton in 1697. See Sir J. Floyer—"An Enquiry into the Right Use of . . . Baths in England, pp. 113-117. Dr. Garnett places this well half a mile to the east of the sulphur wells at Harrogate. S. Lewis in his "Topographical Dictionary," 1849, says it was in Bilton Park, while in Hargroves "History of Knaresborough," &c., it is given as one mile west of the Queen's Head.

from quarries in this formation.* The stone used by the Romans in the building of Isurium (Aldborough) is supposed to have come from the Magnesian Limestone in the neighbourhood of Staveley.†

It is, however, too easily affected by the weather to form a lasting material for outside work. On exposure to frost the mass of the rock flakes off and crumbles away, leaving the sparry veins standing out as ridges. For inside work it is well adapted, as the stone can be easily worked and is of a good colour.

The only other rock that can be used in building construction is the Bunter Sandstone, but this is generally far too soft to be available for the purpose. It has however been used to some extent in the neighbourhood of Ripon and Boroughbridge.

About Easingwold the flaggy beds of the Middle Lias have been used for paving footpaths, but the outcrop is too limited for the practice to become very general.

Lime.—The Magnesian Limestone has been extensively quarried for burning lime. The rock has been worked at many places, particularly near Knaresborough and to the south of Ripon, but the most extensive quarries at the present time are those at Wormald Green. The rock here is a grey magnesian limestone, which when calcined gives the following analysis.‡

Analysis of Lime.—Wormald Green.

| | | | | | | |
|---------------------------|---|---|---|---|---|-------|
| Calcium oxide | - | - | - | - | - | 72.71 |
| Magnesia | - | - | - | - | - | 19.26 |
| Oxide of Iron and Alumina | - | - | - | - | - | 1.55 |
| Silica | - | - | - | - | - | 1.76 |
| Carbon di-oxide | - | - | - | - | - | 3.05 |
| Sulphuric anhydride | - | - | - | - | - | .97 |
| Combined water, &c. | - | - | - | - | - | .70 |

100.00

This varies a little, having sometimes a larger percentage of calcium oxide and less magnesia.

Some of the quarries in this neighbourhood consist of hard grey and blue beds, which are very valuable for agricultural lime, owing to the large percentage of calcium oxide that they contain; whilst the whiter beds containing a large percentage of magnesia make a valuable building lime.

At Well, to the north of Ripon, the rock is more uniform and

* York Minster was partly built of stone from Jackdaw Crag, Thorpe Arch; and Beverley Minster of that from Smawse Quarry, Bramham Moor.

† J. J. Sheahan and T. Whellan, "History and Topography of the City of York," vol. iii., p. 182.

‡ For the particulars and analysis of the lime at Wormald Green and Well we are indebted to Mr. F. Hymas, of Burton Leonard.

blue in colour, forming a good road-metal and excellent for agricultural lime, of which the following is an analysis.

Analysis of Lime at Well.

| | | | | | | |
|-------------------------------------|---|---|---|---|---|--------------|
| Calcium oxide | - | - | - | - | - | 86.51 |
| Magnesia | - | - | - | - | - | 1.39 |
| Oxide of Iron and Alumina | - | - | - | - | - | 2.77 |
| Silica- | - | - | - | - | - | 3.73 |
| Carbonic anhydride, combined water, | | | | | | |
| &c. | - | - | - | - | - | 5.60 |
| | | | | | | <hr/> 100.00 |

As the chemical composition of the Magnesian Limestone appears to vary somewhat throughout this area, it may be interesting to compare the analysis of the unburnt limestone in the south of the map with that in the north. The analyses, by Mr. Holme, given below are quoted from Professor Sedgwick's paper on the Permian Series.*

Earthy variety of Magnesian Limestone from Ripon.

| | | | | | | |
|-------------------------------|---|---|---|---|---|----------------------|
| Carbonate of lime | - | - | - | - | - | 71.125 |
| Carbonate of magnesia | - | - | - | - | - | 25.625 |
| Red oxide of iron and alumina | - | - | - | - | - | 1.750 |
| Silica, a trace of, and water | - | - | - | - | - | 1.500 |
| | | | | | | <hr/> 100 grs. <hr/> |

Earthy variety of Magnesian Limestone from Knaresborough.

| | | | | | | |
|-------------------------------|---|---|---|---|---|----------------------|
| Carbonate of lime | - | - | - | - | - | 72.00 |
| Carbonate of magnesia | - | - | - | - | - | 25.50 |
| Red oxide of iron and alumina | - | - | - | - | - | 1.50 |
| Silica, a trace of, and water | - | - | - | - | - | 1.50 |
| | | | | | | <hr/> 100 grs. <hr/> |

The lime from the Magnesian Limestone is said to produce a mortar which sets with extreme hardness; but for agricultural purposes it is too caustic to allow a large amount to be used at once.

Coal.—Two or three thin coal seams occur in the Millstone Grit rocks. These were many years ago worked at Bilton, and used for burning the Magnesian Limestone of the neighbourhood. The upper seam was 3ft. 2ins. thick, while the lower was 2ft. 9ins. but thinned away towards the north. The measures are much disturbed here by the Harrogate anticline, so there would probably be much difficulty in working these thin seams.

These seams have also been worked in several places to the north and west of Harrogate, but they do not appear to have

* *Trans. Geol. Soc.*, ser. 2, vol. iii. p. 87.

been of much importance. Winch mentions coal being found at Easingwold,* but this probably refers to the coals which were obtained from the Oolites further to the north.†

Sand and Gravel.—Thick deposits of sand and gravel occur very generally throughout the district, especially over the central area, and in the low ground east of the River Ouse. The coarse glacial gravels, which occur at Grafton and elsewhere, were formerly extensively worked for road material; but since the introduction of the igneous rocks for this purpose most of these pits have been closed.

There are also some extensive deposits of river gravel along the banks of the Nidd below Knaresborough which have been worked from time to time.

At the base of the Magnesian Limestone we have noticed certain sands, which in the neighbourhood of the Coalfield were used for moulding purposes. The outcrop of these sands in the present district appears to be very limited; but if they should prove to be of value it is very probable that further exploration might reveal a more extended development of them.

Gypsum.—Gypsum occurs in the Magnesian Limestone at Bilton, in the Trias at Green Hammerton, and in the marls on the banks of the Ure at Ripon. It does not appear, however, to have been worked to any extent, and the beds are probably too thin to be of much commercial value.‡

Celestite and Strontianite.—Sulphate of Strontium occurs on the banks of the Nidd at Bilton§ and also at Green Hammerton.¶ Carbonate of Strontium is stated to have been found at Merryfield near Pateley Bridge.||

Copper-ore.—Green Carbonate of Copper is said to have been obtained in considerable quantity at Farnham, north of Knaresborough, "by means of galleries worked through the limestone," and at Newton Kyme, near Tadcaster.**

Water Supply.—The principal water-bearing rocks of the district are the Millstone Grit, the Magnesian Limestone and the

* *Phil. Mag.*, vol. xlvii., p. 100.

† See *Mem. Geol. Survey*. "The Geology of the Country around Northallerton and Thirsk," p. 37.

‡ The occurrence of alabaster is noted by Dr. French near Harrogate, who also states that "glittering sand with some gold" was found there.—"The Yorkshire Spaw," 1652.

§ J. Sowerby, "British Mineralogy," 1817, vol. v., p. 75, tab. 444. Dr. Murray, *Trans. Geol. Soc.*, 1817, vol. iv., p. 445. Crystals of Celestine from here are in York Museum.—*Ann. Rep. Yorkshire Phil. Soc.* for 1887, p. 34.

¶ J. Farey, *Phil. Mag.* 1812, vol. xxxix., p. 106.

|| *Edin. Phil. Journ.* 1825, vol. xii., p. 178. This is stated by R. H. Davis to be the double Carbonate of Baryta and Strontia.—*Chem. News*, vol. xiii. p. 303.

** W. Marshall, *Trans. Geol. Soc.*, ser. 2, vol. ii., p. 140.

Triassic Sandstones. The Millstone Grit, however, must be regarded as the most important source of supply; but its outcrop in the immediate district covers such a limited area, and the rock itself has been subjected to such frequent folding and faulting, that the amount of water available from these rocks cannot be expected to be very great. For these reasons the larger towns, Harrogate, Knaresborough and Ripon, have been compelled to seek their supply from a greater distance, and to construct reservoirs in the upland valleys to the west.

At the present time Harrogate derives its supply from reservoirs at Scargill and Beaver Dyke in the drainage area of the Oak Beck, which collect the water falling on the moorlands to the west; but these will be supplemented by further works that are being undertaken at Roundhills in the valley of the Pott Beck, a tributary of the Burn which flows into the River Ure at Masham.

The following particulars as to the Harrogate water supply have been furnished by Mr. F. J. Dixon.

The works were established in 1846 and purchased by the Local Authority in 1898. The Storage Reservoirs are:—

| | Capacity in gallons. | Watershed in acres. |
|-----------------------|-------------------------|------------------------|
| Scargill - - - - | 200,000,000 | 1,100 |
| Upper Beaver Dyke - - | 30,000,000 | 1,260 |
| Lower Beaver Dyke - - | 118,000,000 | |
| Ten Acres - - - - | 35,000,000 | 410 |
| Roundhills - - - - | 575,000,000 | 3,000 |

The average annual Rainfall over the Drainage Area is 28·58 inches (period 11 years). Calculated 30 years mean 30·20 inches. The area supplied by these works includes the towns of Harrogate and Knaresborough together with the parishes of Pannal, Bilton, Starbeck, Scriven and Knaresborough.

The analyses of two of these waters are as follows. The samples contain in grains per gallon (parts per 70,000), after filtration:—

| | Scargill. | Beaver Dyke. |
|---|-----------|-----------------|
| Chlorides equal to common salt - - - - | 1·84 | 1·84 |
| Calcium sulphate - - - - | 4·55 | 4·08 |
| Calcium and Magnesium carbonates, &c., - - - | trace | 0·09 |
| Volatile and organic matter - - - - | 0·05 | 1·80 |
| Total dissolved solids - - - - | 6·44 | 7·81 |
| Chlorine - - - - | 1·12 | 1·12 |
| Ammonia - - - - | 0·008 | 0·002 |
| Organic ammonia - - - - | 0·003 | 0·007 |
| Oxygen required to oxidise organic matter in four hours | 0·003 | 0·148 |
| | Degrees. | |
| Hardness before boiling - - - - | 2·7 | 3·1 |
| Hardness after boiling - - - - | 2·5 | 3·0 |

The Ripon supply is obtained from a reservoir having a capacity of about 88,000,000 gallons on Lumley Moor,* about five miles

* Lung'ey on Ordnance Map.

west of the town. The following analysis by Mr. A. H. Allen (September 1899) has been communicated by Mr. J. W. Kirkley:—

| | Grains per gallon. | Grains per gallon. |
|----------------------------|--|-----------------------|
| Total solid matter - - - | 5.74, which lost on ignition - - | 1.04 |
| Chlorine - - - | 0.90, equal to Sodium chloride - - | 1.48 |
| Nitrogen in oxidised forms | None, equal to Nitric acid (anhydrous) | None |
| | Degrees. | |
| Hardness - - - - - | 6.0 | |
| | Parts per million | |
| Oxygen absorbed - - - | 0.95 | |
| Free ammonia - - - | 0.04 | |
| Albuminoid ammonia - - | 0.01 | |

The water supply of Easingwold is derived from the Middle Lias; while excellent springs of water also issue from the base of the Oolites in that neighbourhood. The following analyses show the character of some of the waters derived from these sources:—

Communicated by Messrs. Fairbank and Sons, Driffield.
Analyses of three samples of water by J. Baynes. March 1890.

| | A A spring opposite Banks Farm. | B Hanover Farm. | C Oulston Spring | |
|-----------------------|--|-----------------------|------------------------|----------------------|
| Total solid residue - | 22.40 | 22.00 | 26.25 | Grains per gallon. |
| Chlorine - - - | 1.10 | 1.23 | .90 | } Parts per million. |
| Free Ammonia - | .0214 | None | None | |
| Albuminoid Ammonia | .0230 | .008 | .014 | |

A [Probably from the Middle Lias, but through a thin covering of Boulder clay.] A water of a high degree of purity.

B. From a boring in Bog Field about 300 yards east of Banks Farm. [From the Boulder clay overlying Lias, probably from the Middle Lias.] A water of extraordinary degree of purity. Issues from three 3 in. boreholes at the rate of 54,648 gallons per 24 hours (April 1891). This is the water selected for the supply of the town of Easingwold.

C. [Issues from the base of the Lower Oolites.] A water of extraordinary degree of purity.

Both the Magnesian Limestone and the Triassic Sandstones, from their open porous character, collect a large amount of water, which has been utilised in some cases; but, owing to the quantity of gypsum associated with these rocks, it is liable to be excessively hard, and quite unfit for domestic purposes.

Besides these rocks a considerable amount of water may be obtained from the Glacial gravels, which are scattered over a large part of the district, especially along the range of rising ground in the centre of the map, and over the undulating hills

in the Vale of York. Its occurrence, however, is very uncertain, and as in the neighbourhood of villages it is liable to contamination, it is not a source to be generally recommended.

The only remaining source of water supply is that to be derived from the rivers. This in the case of York is drawn from the River Ouse, a short distance below the drainage area of this district. Two analyses of this water are added for comparison:—

Analysis of Filtered Water.

From a Report of the York Waterworks Company, 1903.

| | Parts per 100,000. |
|-------------------------------------|-----------------------|
| Silica - - - - - | 32 |
| Oxide of iron and alumina - - - - - | 72 |
| Carbonate of lime - - - - - | 11.27 |
| Sulphate of lime - - - - - | 2.57 |
| Nitrate of lime - - - - - | 21 |
| Sulphate of magnesia - - - - - | 1.82 |
| Chloride of sodium - - - - - | 2.58 |
| Organic matter and loss - - - - - | 1.61 |

Total solid residue 21.10

| | Parts per 100,000. |
|---|-----------------------|
| Chlorine - - - - - | 1.57 |
| Free ammonia - - - - - | 0.000 |
| Albuminoid ammonia - - - - - | 0.004 |
| Oxygen absorbed in 15 minutes at 80° F. - - - - - | 0.36 |
| Oxygen absorbed in 4 hours at 80° F. - - - - - | 0.40 |
| Nitrogen in nitrates and nitrites - - - - - | 0.024 |
| | Degrees Clarke. |
| Temporary hardness - - - - - | 7.2 |
| Permanent „ - - - - - | 1.5 |

Total hardness - 8.7

Analysis of the water supplied by the York Waterworks Company, by Mr. Patterson, December, 1876.

Local Government Board Report, 1885. No. 4.

| | Grains per gallon. |
|--|-----------------------|
| Total solid matter dried at 212° F. - - - - - | 15.700 |
| Chloride of sodium - - - - - | 1.500 |
| Ammonia - - - - - | trace |
| Albuminoid ammonia - - - - - | 0.005 |
| Nitrogen existing as nitrites and nitrates - - - - - | 0.059 |
| Oxygen required to oxidise organic matter - - - - - | 0.122 |
| | Degrees. |
| Hardness before boiling - - - - - | 12.1 |
| Hardness after boiling one hour - - - - - | 7.4 |

The water was very clear, containing a very minute trace of matter in suspension. It had a slight brownish-yellow tinge of colour, arising from the presence of peaty matter; the amount was so slight as to be unobjectionable. The water is quite free from odour, and it is very pleasant to taste. It is very free from nitrogenous organic impurities, and is a wholesome and pleasant drinking water.

(Signed) JOHN PATTERSON.

CHAPTER IX.

HISTORY AND ORIGIN OF THE HARROGATE SPRINGS.

Of the early history of Harrogate very little is known. The place is first mentioned in the Stuteville charter about 1200, where it is designated Harelow.* With regard to the etymology of the name there appears to be some difference of opinion amongst the older writers. Hargrove states that it was originally called Herrigate, from the frequent invasion of the Danes and other nations.† Hunter and Lewis give the old name as Heywragate, from its situation on the road from Knaresborough to Heywray (Haverah Park).‡ The great forest of Knaresborough which extended from that town to the valley of the Wharfe about Bolton Abbey included the area where Harrogate now stands. In the reign of Elizabeth much of the timber was cut down for smelting the iron ores of the neighbourhood.§ Harrogate, however, is rarely mentioned before the discovery of the first spring in the 16th century. This was in 1571, when Capt. Slingsby, on his return from Westphalia, discovered the Tewit Well, or English Spaw, noticing that the water was very similar to what he had seen in that country.|| Soon after its discovery Dr. Bright wrote on its virtues and uses, and in 1626 Dr. Dean published his *Spadacrene Anglica*, which is the earliest general account of these waters.|| The next spring to be discovered was the Old Sulphur Well, and this was followed by the Old Spaw, or Sweet Spaw, afterwards called John's Well.** The dates, however, of these discoveries are uncertain, but as the Old Sulphur Well is mentioned by Dean, it must have been known previous to 1626, and was not discovered subsequently to that date, as has been stated by some authors. The Old Spa is claimed to have

* By this charter a portion of the Forest of Knaresborough, including Harrogate, was granted by William de Stuteville to the Plumpton.

† Here in Saxon signifying an army. "History of the Castle, Town and Forest of Knaresborough." By E. Hargrove, 1775, p. 41.

‡ "A Treatise on Mineral Waters of Harrogate and its Vicinity," By Dr. A. Hunter, 1830. "Topographical Dictionary of England." By S. Lewis, 1849.

§ These furnaces were at the neighbouring village of Kirby Overblow, which in an old MS. of the time of Edward I. was known by the name of Kirby-Ore-Blowers. Ralph Thoresby, "Ducat Leodiensis," 1715, p. 166.

|| In Hargrove's History of Knaresborough and the Guides published in 1840, and in those by J. Thorpe and T. Inchbold, it is stated that the Old Spaw was the first well discovered by Slingsby, but this is an error.

|| Dr. W. Buchan states that the Harrogate Waters were first brought into repute by Dr. Daltry, of York. "Cautions concerning Cold Bathing, and drinking Mineral Waters," p. 16. 1786.

** The name John's Well was derived from John Hardestie, the attendant. It is often erroneously called St. John's Well.

been discovered by Dr. Stanhope in 1631. During the 17th century the importance of the springs became more known, and the accommodation for visitors had to be increased.*

During the greater part of the 18th century the country around Harrogate was very wild and uncultivated, but in 1770 an Act was passed for the enclosure of the Forest of Knaresborough, and the value of the mineral waters was so prized that 200 acres of land, including many of the springs, were reserved to be free and unenclosed, forming the common now known as the Stray.

The Alum Well, in the Bogs Field, was discovered in 1733, being subsequently lost, but re-discovered again in 1870.

The spring in the Crescent Gardens was discovered by chance in digging for water in 1783.

In the early part of the 19th century the mineral waters of Harrogate became more appreciated, and various other springs were discovered from time to time—the Cheltenham (Chloride of Iron) spring in 1819†, those in the Montpellier Gardens in 1822, and those at Harlow Car about 1840, while since that date many others have been added to the list; so that at the present time there are said to be 80 known springs, differing in strength and quality, the Bogs Field alone containing 36 separate springs. The existence of so many springs, no two of which are alike, issuing side by side, is unique, and has given rise to various opinions from geologists and others as to the probable causes of this remarkable occurrence. Dr. Garnett, William Smith, Edwin Lee, Professors Phillips, Turner, Williamson, Daniel and Johnstone, William West, Nicholas Brown, Dr. Murray, Dr. Clanny, John Buddle, Dr. Oliver, and others have all expressed opinions as to the origin and cause of these springs‡. Amongst these there is a general agreement, although they differ on minor points, that the majority of the springs are deep-seated, that the water is obtained from a distance, and that the cause of the great variety of the springs and of their issuing at this particular spot is due to the peculiar geological structure of the neighbourhood.

A full account of the geology of the district has already been given in the previous pages of this memoir, so that it will not be necessary to recapitulate more of the account of the general structure of the rocks than so far as it affects the origin of these springs. Harrogate, as we have noticed, is situated at the eastern termination of the great anticline which traverses this part of Yorkshire; and there can be but little doubt that it is due to this fact that mineral springs occur here in such abundance, and of so varied a character. The strata which are bent up by this anticline are the lower members of the Carboniferous series—the Millstone Grit, the shales and sandstones associated with the Harrogate

* The first inn, called the Queen's Head, now the Queen's Hotel, was built in 1687.

† This spring was discovered by boring. R. H. Davis, *Chem. Soc. Journ.*, 1873, pp. 1089-92.

‡ These statements and opinions are published by W. Grainge in his *Geology of Harrogate*, 1864.

Roadstone, and the Mountain or Scar Limestone; these three principal divisions are further sub-divided into their separate beds of sandstone, shale, limestone or chert, some of which have very distinctive characters, which they retain throughout large areas. The Millstone Grit of this district is for the most part a series of some half-a-dozen beds of coarse grits, separated from each other by thick beds of shale. A very good section of these beds is exposed along the railway cutting from Harrogate to the south; but the best idea of the nature of the grits themselves is obtained from Plumpton Rocks, Birk Crag, and Almes Cliff Rocks. It is these rocks which, stretching over the moorlands to the west, form some of the grandest and wildest of the Yorkshire scenery.

The series of rocks, which include the beds that we have called the Harrogate Roadstone, consist in the upper part of dark blue shales, these being succeeded by thin bands of earthy limestone and chert containing Encrinites. This latter is a hard siliceous rock, with a conchoidal and hackly fracture, but it is very frequently much decomposed, having the calcareous portion dissolved out, when it resembles pumice-stone in texture. It is extensively quarried in the neighbourhood for mending roads. These cherty beds rest on dark blue shales containing sulphur, iron, and probably several other chemical substances, and below these again there is a thin rubbly sandstone also containing sulphur and iron, resting on other beds of shale, which are the lowest strata visible in the district.

The precise equivalents of these measures to the west are rendered somewhat doubtful by the thinning out of one or more of the beds to the west of Harrogate; for in the country west of the Millstone Grit area, where we should expect to find the same measures cropping up, there are no rocks that exactly correspond to those at Harrogate. The reason of this is, either that these measures gradually become thinner until they finally disappear in their passage to the west, or that they are so altered in their general composition as to be no longer recognisable as the same beds. When such changes as these take place in an isolated area like Harrogate, it is extremely difficult to identify the beds or to say exactly to what part of a formation they belong. In this case the only clue to their correlation with the strata of a known area is the lithological character of the rocks, and even this is not always to be depended upon. But we shall not be far wrong in considering these beds at Harrogate a portion of the Pendleside Series, for it is evident they lie below the Millstone Grit, while at the same time they must be above the Scar Limestone.

The strata which occupy the district to the west of Harrogate and south of Settle are thrown into a series of nearly parallel anticlinal and synclinal folds, ranging E.N.E. or N.E., of which the most remarkable are those in the neighbourhood of Bolland and Clitheroe, by which the Scar Limestone and the beds of the Pendleside Series are frequently brought to the surface, and extend in long lines across the country to Skipton and Appletreewick,

whence the direction is nearly east towards Harrogate and Ripon. Along these lines the higher and middle members of the Millstone Grit rocks are wanting, and the lowest beds of Millstone Grit crop out, enclosing elongated patches of Lower Carboniferous rocks. If it were not for these anticlines, the Millstone Grit might be separated from the rocks below by a nearly north and south line ranging along the western side of Great Whernside, Rylstone Fell, and Skipton; then in a general way, with the exception of some of the higher hills which are capped with Millstone Grit, all the country lying west of this line would be composed of Lower Carboniferous rocks, while that to the east would have the various members of the Millstone Grit; as it is, this regularity is broken by the disturbances mentioned above, so that the base line of the Grit retreats considerably further to the east in the neighbourhood of Greenhow Hill and Skipton.

On the northern of these two lines of disturbance the sulphur well at Aldfield is situated, while the southern anticline upon which Harrogate stands is a continuation of that at Skipton, although its direction in the neighbourhood of Harrogate is about N.E. and not nearly E., as this would lead us to infer. Its course across the moors from Bolton Abbey to Harrogate is well marked on the high ground about Beamsley Beacon, but thence eastwards it is not so apparent until the lower beds are brought up within a mile or two of Harrogate, when its general outline again becomes very distinct.

At Harrogate the general geological structure is rendered very clear by the massive grits at Pannal and Birk Crag, where the same bed of grit, striking in a north-east direction, forms, as it were, a wall on either side of the anticline, and gives at a glance the key to the main geological features of the neighbourhood. The axis of this disturbance is well shown in the town of Low Harrogate by the quarries that have been opened for roadstone on either side of the Bogs Field, where the rock may be seen dipping respectively N.W. and S. E. at high angles on either side of this valley; the same thing occurs near Beckwith Shaw to the S.W. of Harrogate. From these two positions the general run of the axis of disturbance may be easily gathered.

The exact base of the Millstone Grit is not so easily traceable in all cases, and can only be followed by very close inspection and consideration of the country. On the southern side of the anticline its general course is from the south of Pannal Ash, across the Stray to High Harrogate; to the north of the town its outcrop being obscured by faults is not so well marked, the junction with the underlying measures ranging along a N.E. line from near Shaw Green, to the north of Harlow Hill and Low Harrogate. Between these two lines is an area of about three square miles of lower measures upon which the town of Low Harrogate is situated.

The highest point of this area is Harlow Hill, 600 feet above the sea, and it is here that the greatest amount of disturbance appears to have taken place. The sandstone which caps this hill

is one of the lowest beds of the district; and underlies the road-stone of Harrogate and Beckwith Shaw, towards both of which places it has a considerable dip. About a mile on either side of this hill occur most of the principal Sulphur Springs of the district.

Let us now turn to the chemical side of the question, and see what are the principal constituents of the waters. A very large number of analyses of these waters have been published from time to time, as may be seen from the list of works given in the bibliography. Those given on the opposite page are the most recent that we have been able to come across. These show that the principal constituents contained in these waters enable them to be separated into two distinct groups, the one containing an alkaline sulphide and the other a proto-salt of iron. These may be divided into a series of sub-groups or classes according to their chemical constitution, and the amount of saline matter they contain.

GROUP I.—SULPHUR WATERS.

| | | | |
|------------------------|--------|---|--|
| | Strong | { | The Old Sulphur Water. The Strong Montpellier Sulphur Water |
| Saline Sulphur - | Mild | { | The Mild Sulphur Water. The Mild Montpellier Sulphur Water. The No. 36 Water. The Magnesia Water. The Crescent Saline Water. |
| Alkaline Sulphur - - - | | { | The Starbeck Sulphur Water. The Beckwith Sulphur Water. The Harlow Car Sulphur Water. |

GROUP II.—IRON WATERS.

| | | |
|---------------------|---|---|
| Saline Iron - - - - | { | The Kissingen Water. The Chloride of Iron Water. The Alum Well. The Alexandra Water. |
| Pure Chalybeate - | { | The Tewit Well. The Johns Well. The Pure Chalybeate Well. |

| Saline Constituents in Grains per Gallon. | Old Sulphur Well Royal Pump Room (Thorpe) | Strong Sulphur Well Montpellier (Attfeld). | New or Mild Sulphur Well Royal Pump Room (W. A. Miller). | Mild Sulphur Well Montpellier (Attfeld). | Magnesia Well (Munpratt). | Starbeck Spa (Fairley). | Beckwith Spring. | No. 36. Sulphur Well. |
|---|---|--|--|--|---------------------------|-------------------------|------------------|-----------------------|
| Sodium Sulphate | 5.215 | — | 6.89 | — | — | — | — | — |
| Sodium Sulphide | — | 14.500 | — | 8.777 | .707 | 1.515 | 1.929 | 1.1 |
| Barium Chloride | 6.566 | — | trace | — | 1.222 | trace | — | — |
| Strontium | — | 2.816 | — | 6.19 | trace | — | — | — |
| Calcium | 43.635 | 79.936 | 16.70 | 31.296 | — | — | — | — |
| Magnesium | 48.281 | 57.989 | 2.39 | 27.589 | 1.792 | — | — | 26.4 |
| Potassium | 9.592 | 4.811 | 11.34 | 5.691 | 27.913 | — | 6.10 | .5 |
| Lithium | .753 | trace | trace | — | — | 0.070 | trace | .4 |
| Ammonium | 1.031 | .996 | — | .656 | trace | trace | — | — |
| Sodium | 893.670 | 827.371 | 582.95 | 388.800 | 215.896 | 109.890 | 3.374 | 241.6 |
| Magnesium Bromide | 2.283 | — | — | — | trace | trace | — | 11.1 |
| Magnesium Iodide | .113 | — | — | — | trace | trace | — | 7.2 |
| Sodium | — | — | — | — | — | 0.001 | — | — |
| Ammonium Carbonate | — | — | — | — | — | 0.225 | — | — |
| Calcium | 29.768 | 8.750 | — | 16.711 | 18.476 | 7.825 | 5.947 | — |
| Magnesium | 5.953 | — | — | — | 12.799 | 4.119 | 4.222 | — |
| Ferrous | — | — | — | — | — | 0.072 | — | — |
| Potassium | — | — | — | — | — | 1.745 | — | 14.529 |
| Sodium | — | — | — | — | — | 17.104 | 16.147 | — |
| Barium | — | — | — | — | — | 2.275 | — | .53 |
| Strontium | — | — | — | — | — | 0.141 | — | — |
| Barium Sulphate | — | .418 | — | — | — | — | — | — |
| Strontium | — | .529 | — | .913 | — | — | — | — |
| Calcium | — | — | — | — | — | 1.88 | .580 | — |
| Sodium Silicate | — | — | — | — | — | 2.073 | — | — |
| Sodium Nitrate | — | .900 | — | .370 | — | — | — | — |
| Silica | .701 | 3.570 | 2.40 | 3.836 | 1.608 | 3.27 | .530 | .7 |
| | 1047.561 | 1002.586 | 654.87 | 485.258 | 280.413 | 151.59 | 33.339 | 300.4 |
| Gases in Cubic Inches. | | | | | | | | |
| Sulphuretted Hydrogen | 10.16 | — | 4.18 | — | — | 1.87 | — | 5.6 |
| Carbon Dioxide | 40.10 | 60.00 | 13.22 | 54.00 | 11.50 | 2.71 | — | 30.5 |
| Carburetted Hydrogen | — | 2.30 | — | .80 | — | — | — | — |
| Nitrogen | — | 3.70 | 2.01 | 3.20 | — | 6.34 | — | — |
| | 50.26 | 66.00 | 19.41 | 58.00 | 11.50 | 10.92 | — | 36.1 |

TABLE OF ANALYSES OF THE SALINE CHALYBEATE AND PURE CHALYBEATE GROUP.

| Saline Constituents in Grains per Gallon. | Kissingen Spa. (Attfeld). | Chloride of Iron Spa (Thorpe). | Alexandra Chalybeate (Davis). | Carbonate of Iron Spa (Muspratt). | Pure Chalybeate, Royal Pump Room (Davis). | Tewit Well (Hofmann). | John's Well, or Old Spa. | Alum Well (Davis). |
|---|---------------------------|--------------------------------|-------------------------------|-----------------------------------|---|-----------------------|--------------------------|--------------------|
| Ferrous Sulphate | — | — | — | — | — | — | — | 69.33 |
| Ferric | — | — | — | — | — | — | — | 78.76 |
| Aluminium | — | — | — | — | — | — | — | 89.47 |
| Calcium | — | — | 9.097 | 7.625 | .740 | .697 | .307 | 56.91 |
| Magnesium | — | — | — | — | — | — | — | 57.33 |
| Potassium | — | — | — | — | — | — | — | 3.14 |
| Ammonium | — | — | — | — | — | — | — | 2.19 |
| Barium | .509 | .222 | — | — | — | — | — | — |
| Ferrous Chloride | — | 13.213 | — | — | — | — | — | — |
| Potassium | 21.425 | 3.205 | 1.130 | .150 | — | 1.323 | — | — |
| Sodium | 674.588 | 277.561 | 176.370 | 11.650 | 1.625 | .280 | 1.543 | 33.96 |
| Ammonium | .439 | .406 | trace | — | trace | trace | trace | — |
| Barium | — | 5.204 | — | — | — | — | — | — |
| Strontium | .887 | .624 | — | — | — | — | — | — |
| Calcium | 87.337 | 94.015 | — | 2.311 | trace | trace | — | — |
| Manganese | — | .971 | trace | — | — | — | — | — |
| Magnesium | 65.391 | 57.315 | 4.736 | 13.148 | — | — | — | — |
| Lithium Iodides, Bromides, Fluorides | — | — | — | — | — | — | — | — |
| Ferrous Carbonate | traces | traces | traces | — | trace | trace | — | — |
| Barium | 9.590 | 11.050 | 5.800 | 6.042 | 1.364 | 1.358 | 1.271 | — |
| Calcium | 2.136 | — | — | — | — | — | — | — |
| Magnesium | 8.858 | — | 13.762 | .341 | 1.532 | 1.435 | 2.264 | — |
| Potassium | — | — | 5.785 | — | 1.952 | 2.667 | 3.039 | — |
| Sodium | — | — | — | — | .262 | 1.057 | .991 | — |
| Silica | 3.570 | 1.414 | .675 | .204 | 1.103 | 1.041 | 1.338 | — |
| Organic matter | — | — | 1.450 | — | .502 | .063 | trace | 3.27 |
| | 874.740 | 465.200 | 218.804 | 41.471 | 9.839 | 10.521 | 10.753 | 394.41 |
| Gases in Cubic Inches. | | | | | | | | |
| Carbon Dioxide | 21.3 | 53.55 | 17.04 | — | 13.74 | 11.85 | 14.95 | — |
| Carburetted Hydrogen | — | — | — | — | — | — | .15 | — |
| Oxygen | 1.5 | — | .31 | — | .82 | .40 | .67 | — |
| Nitrogen | 5.2 | — | 8.98 | — | 8.00 | 5.33 | 6.35 | — |
| | 28.3 | 53.55 | 26.33 | — | 22.53 | 17.78 | 22.12 | — |

From the above tables it is seen that the Harrogate mineral waters consist of four or five distinct classes, each of which has a certain marked peculiarity in its chemical constitution. The Strong Sulphur is very rich in chlorides and sulphides with a large bulk of free gases. The Mild Sulphur has nearly the same constituents but in a less concentrated condition. The Saline Chalybeate is very rich in chlorides and carbonates but contains no sulphides. The Pure Chalybeate contains a much smaller proportion of saline ingredients than either of the preceding; in fact it more nearly resembles the ordinary kinds of drinking water with a rather larger percentage of the carbonates of magnesia and iron.

It is not our purpose, however, to go into the chemical constitution of these waters, but rather to note what connection there may be between so great a variety of classes of water and the geological structure of the neighbourhood. All the writers on this subject agree in considering that the mineral waters of Harrogate are owing to the peculiar geological structure of the district, but they differ somewhat in their ideas as to their origin. Some, and they are rather a majority, consider that most if not all the Harrogate mineral waters have a common source; and that the differences in the springs, which are only partial, are occasioned by the different channels through which they reach the surface. Others again consider that each spring has its own independent source, and that it exerts no influence over any of the neighbouring springs as long as the water remains below the surface. Professor Phillips in his description of the geology of this part of Yorkshire considered that the Chalybeate and Sulphur springs of Harrogate originate from the junction of two lines of fault, one running nearly north-east, and the other about due north*. With regard to the first of these two lines of fault, it is very apparent that there is at least one if not several faults running in a more or less north-east direction and parallel to the main axis of disturbance; but from the manner in which the Harrogate anticline is enclosed both on the north and south sides by great ridges of grit striking across the country in an unbroken line for some considerable distance on either side of Harrogate, it is not possible that the strata can be broken by a north and south line without the dislocation being more apparent, and even supposing there were a cross dislocation there is no reason to suppose that it would influence the underground water at Harrogate any more than at hundreds of other places where the same thing occurs. It seems much more probable that the real source of these springs is from the same or nearly the same beds of shale as those from which they issue at Harrogate; that they are confined to this group of strata throughout their entire course; and that the faults and disturbances at Harrogate exert only a minor influence on the peculiarity of the waters. In the country west of Harrogate the strata in a general way consist of massive grits separated from one another by varying thicknesses

* "Illustrations of the Geology of Yorkshire," Part II., p. 253.

of shale which are thrown into a series of undulations, but are not broken by any faults of much importance. These beds, according as they partake of the sandstone or shaly character, become pervious or impervious to the passage of water, the sandstones allowing the percolation of water through their substance in all directions, whereas the shales admit its passage only in the direction of the planes of lamination, and only then when they have become tolerably arenaceous. From this it follows that water which issues from a certain orifice, say the Old Sulphur Well at Harrogate, would be confined throughout its entire course to the same strata, although probably not to exactly the same beds as those between which it springs at Harrogate unless the contiguity of the shales were broken by large faults, and these as we have noticed do not occur in the region to the west.

There is another circumstance to be taken into consideration, and that is the thinning out of some portion of the strata. The effect of this would be that, in the case of thinning out occurring towards the west, a stratum of water entering the ground in that region would become divided by the wedge-like nature of the rocks, so that two or more springs might still have the same source in the first case, but have become gradually separated in their passage eastwards. Supposing, on the other hand, that the thinning out took place in the opposite direction, the effect of course would be exactly the reverse; so that the water which entered the ground by several channels would become united into one stream by the gradual dying out of the intermediate rocks.

One great proof of the separation of the several springs at Harrogate is that the water in the wells, often only a few feet apart, stands at totally different levels, and that pumping from one well does not affect another; whereas if there were a common source for the water in the immediate neighbourhood, the same pressure would be exerted in all cases, the water would stand at the same level in all the wells, and the pumping the water in one well would in an equal degree affect all the neighbouring wells. If this be true, then, that each spring is confined throughout its entire course to the same, or nearly the same, geological horizon as that from which it issues, its origin will be where the same strata comes to the surface in the high ground to the west. This is, as we have stated, along the valley of the Wharfe, near Bolton and Appletreewick, and beyond, being about twenty miles or more due west of Harrogate. The passage of the water will be after the manner of an inverted syphon; pressure will be exerted by the superior elevation of the strata to the west, which will force water up through the highly inclined rocks at Harrogate.

Again, the temperature of the water forms what may be considered almost a direct proof that the sources of the wells are not superficial while at the same time it also proves that they do not spring from an enormous depth. Dr. Bennett observes "that the temperature of these sulphur springs during the

summer was always above that of springs of fresh water in the vicinity, and that in winter, as in the month of January, when the thermometer has fallen to 29 degrees, these springs were never lower than 41 degrees."*

This shows that the springs are deeply seated enough to be somewhat affected by the internal temperature of the earth, but not so deep as to be beyond the influence of the external temperature of the air, or so deep as to become what are termed warm or hot springs, like those of Bath and elsewhere. Of course this does not apply to the simple Chalybeate waters, which have no peculiar features other than those common to the ordinary class of springs, and some of which are freely acted upon by changes of temperature.

The next point to consider is the different qualities of the water, and how this difference is occasioned. For this purpose the division into classes is exceedingly useful. The geological map shows that all the Sulphur waters with the exception of those at Starbeck issue from some of the lowest strata that occur in the district, and that the Strong Sulphur wells are those nearest to the axis of the anticline, while the Mild Sulphur and the Saline Chalybeates are at a slight distance on either side. The Pure Chalybeates rise irrespectively from both high and low measures, although some of the principal springs of this water issue from the highest strata, that is the Millstone Grit.

Each class of springs, then, in a general way issue from different groups of strata, but there are apparently some exceptions to this rule, arising in many cases, no doubt, from our ignorance of the original orifice of the spring. This may be at some distance from where the water now issues, the latter part of its course having been diverted by superficial material as well as by faults and thrusts in the underlying strata. The effect of the mixing of two classes of water is shown in the springs about the Bogs Field, where the sulphuretted hydrogen of the sulphur water combines with the iron from the Chalybeate springs, and produces the black, dirty-looking water of these wells. Accepting the hypothesis, then, that each class of springs issue from, and are confined to, distinct bands of strata throughout the greater part of their entire course, it does not seem difficult to account for the difference in quality of each of these groups; but if, on the other hand, we assume that there is a common repository for all the wells, and that the water reaches the surface by faults and fissures in the strata, why is it that there is so much difference between these various classes of water? for surely if the supply were drawn from all sorts of strata indiscriminately, the chemical peculiarities would become mingled, and there would be nearly the same constituents in all the springs. Again, if the chemical impregnation of the water took place in its passage to the surface through joints and fissures, the sources from which it would derive its supply of salts must be comparatively near

* "Observations on the Sulphurous Springs of Harrogate," 1843, p. 1.

the surface, the amount would be but limited, and the quantity dissolved by the water would perceptibly diminish in course of time. But this is not the case, for several of these wells are known to give off an enormous amount of saline matter, which was not decreased to any extent since analyses were first made; Mr. Thackwray's wells alone producing as much as fifteen tons of salt in the year.

The stores from which these springs derive their saline matter must extend over a large area, and such an area is afforded by the Lower Carboniferous rocks, which occur at a short distance below the surface west of Harrogate. There are throughout this area undoubtedly several instances of the thinning out and alteration of the different beds, but they probably occur at some little distance from Harrogate, and would in no way affect the distinct qualities of the water, which would not have been acquired until they had become confined to distinct channels. The chemical peculiarities of the water are such that there is no reason for supposing any source other than what these shales could supply when exposed to the action of water. Mr. Hudleston considers that the deoxidation of the sulphides is caused by the decomposition of vegetable matter. "The considerable quantity of carburetted hydrogen, and of nitrogen . . . favours this view, which is much strengthened by the almost complete absence of oxygen, showing that the nitrogen present is due to organic decomposition."*

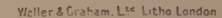
Taking all these things into consideration, it seems the simplest and most probable theory, for theory it must be; firstly, that each spring has its own independent source, with which it is connected by a separate and distinct channel formed by the alternating series of pervious and impervious strata which connects Harrogate with the hilly regions to the west, for it is only from such a source as this that a large body of water could flow year after year with such slight alteration both in quality and quantity; secondly, that the chemical impregnation of the water is caused during its passage through these strata, and that it is from this source that the bases of all the salts are derived.

* *Proc. Yorksh. Geol. Soc.*, vol. viii., p. 123.

.S.



N. E.



APPENDIX I.

BORINGS AND WELL SECTIONS.

Harrogate.

Well at Knox Farm.

(One-inch Map 93, N.W., N.S. 62 ; six-inch Map 154, S.W.)

About 325 feet above Ordnance Datum.

Communicated by Mr. Haigh.

| | Thickness. Ft. in. | Depth. Ft. in. |
|--|-----------------------|-------------------|
| Coarse yellow sandstone - - - - - | 75 0 | 75 0 |
| Blue shale with thin beds of stone - - - - - | 90 0 | 165 0 |

Boring at the Ripon and Skipton crossroads.

About 225 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | | |
|-------------------------------|------|------|
| Soil - - - - - | 1 6 | 1 6 |
| Clay - - - - - | 6 0 | 7 6 |
| Soft sandstone rock - - - - - | 35 0 | 32 6 |

Boring on road 200 yards N. of crossroads.

About 260 feet above Ordnance Datum.

| | | |
|-------------------------------|------|------|
| Yellow sand - - - - - | 10 0 | 10 0 |
| Soft sandstone rock - - - - - | 50 0 | 60 0 |

Boring on road 380 yards N. of crossroads.

About 250 feet above Ordnance Datum.

| | | |
|-------------------------------|------|------|
| Soil - - - - - | 2 6 | 2 6 |
| Sand - - - - - | 8 0 | 10 6 |
| Soft sandstone rock - - - - - | 45 0 | 55 6 |

Boring about 400 yards N.E. of crossroads.

About 325 feet above Ordnance Datum.

| | | |
|---|------|------|
| Yellow sand - - - - - | 10 6 | 10 6 |
| Boulder clay - - - - - | 3 0 | 13 6 |
| Hard blue shale (stratification horizontal) - - - - - | 40 0 | 53 6 |

Boring on road about 230 yards E. of crossroads.

About 300 feet above Ordnance Datum.

| | | |
|---------------------------------|------|------|
| Soil - - - - - | 3 0 | 3 0 |
| Yellow clay - - - - - | 2 6 | 5 6 |
| Hard bedded flagstone - - - - - | 10 6 | 16 0 |
| Blue shale - - - - - | 3 0 | 19 0 |
| Bedded flagstone - - - - - | 1 0 | 20 0 |
| Shale - - - - - | 5 0 | 25 0 |

HIGH HARROGATE.

Well between the Dragon Hotel and the railway.

Communicated by Mr. H. Lee.

| | | |
|----------------------------|------|-------|
| Hard gritty rock - - - - - | 58 0 | 58 0 |
| Soft rock - - - - - | 9 0 | 67 0 |
| Shale - - - - - | 25 0 | 92 0 |
| Soft clay - - - - - | 10 0 | 102 2 |

Starbeck.

(One-inch Map 93, N. W., N.S. 62 ; six-inch Map 154, S. E.)

Boring at S. end of Bogs Lane.
About 320 feet above Ordnance Datum.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---|-----------------------|-------------------|
| Clay - - - - - | 11 0 | 11 0 |
| Red sand and clay mixed - - - - - | 9 7 | 20 7 |
| Red ferruginous stone - - - - - | 3 0 | 23 7 |
| Strong red earth - - - - - | 14 6 | 38 1 |
| Strong blue bind - - - - - | 2 6 | 40 7 |
| Soft stone mineral - - - - - | 11 4 | 51 11 |
| Blue bind - - - - - | 7 8 | 59 7 |
| Black shale - - - - - | 5 7 | 65 2 |
| Galliard - - - - - | 1 0 | 66 2 |
| Blue bind - - - - - | 105 0 | 171 2 |
| Galliard - - - - - | 0 3 | 171 5 |
| Strong blue bind - - - - - | 6 8 | 178 1 |
| Black shale - - - - - | 3 3 | 181 4 |
| Stone bind - - - - - | 0 11 | 182 3 |
| Black shale - - - - - | 117 0 | 299 3 |
| Stone bind - - - - - | 0 9 | 300 0 |
| Strong open black shale - - - - - | 5 8½ | 305 8½ |
| Black shale with mixture of sulphur - - - - - | 131 5 | 437 1½ |

Boring on road 100 yards W. of railway crossing.

About 275 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | Thickness. Ft. in. | Depth. Ft. in. |
|--------------------------|-----------------------|-------------------|
| Alluvium - - - - - | 5 0 | 5 0 |
| Sand - - - - - | 7 0 | 12 0 |
| Running sand - - - - - | 10 0 | 22 0 |
| Grey sandstone - - - - - | 6 0 | 28 0 |

Boring near footpath 330 yards S. of railway crossing.

About 275 feet above Ordnance Datum.

| | | |
|-----------------------------|------|------|
| Alluvium [Drift?] - - - - - | 4 0 | 4 0 |
| Sand - - - - - | 6 0 | 10 0 |
| Soft sandstone - - - - - | 16 0 | 26 0 |

Spofforth.

(One-inch Map 93, N. W., N.S. 62 ; six-inch Map 171, N. E.)

Boring on Follifoot Ridge, about 1,000 yards S. W. of centre of tunnel.

About 425 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | Thickness. Ft. in. | Depth. Ft. in. |
|----------------------------|-----------------------|-------------------|
| Clay - - - - - | 7 0 | 7 0 |
| Blue shale - - - - - | 33 0 | 40 0 |
| Rock and shale - - - - - | 47 0 | 87 0 |
| Hard sandstone - - - - - | 4 0 | 91 0 |
| Sandstone - - - - - | 19 0 | 110 0 |
| Black shaly rock - - - - - | 4 0 | 114 0 |
| Sandstone grit - - - - - | 17 0 | 131 0 |
| Hard rock - - - - - | 3 0 | 134 0 |

KIRK DEIGHTON.

Well in shelly limestone, about 30 yards.

IGMANTHORPE HALL.

Well about 21 yards to limestone. About 70 or 80 yards from this got water at 7 yards, but met with no limestone.

Bilton.

THE HALL.

(One-inch Map 93, S.W., N.S. 70; six-inch Map 173.)
Sand about 20 yards, then Sandstone.

Well between Jewitt House and Blacksmith Arms
opposite end of lane to Healaugh.
Communicated by Mr. Montague.

| | Thickness. | Depth. |
|---------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Fine soil - - - - - | 1 0 | 1 0 |
| Rubble - - - - - | 3 0 | 4 0 |
| Strong red sand - - - - - | about 59 0 | 63 0 |
| Red sandstone. | | |

Good supply of water obtained.

WIGHILL.

Wells about 8 or 9 yards deep. Water from gravel.

Burton Leonard.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 137, S.E.)
Boring 760 yards W. of centre of village.
About 300 feet above Ordnance Datum.
Communicated by Mr. F. J. Dixon.

| | Thickness. | Depth. |
|---------------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Boulder clay - - - - - | 12 0 | 12 0 |
| Marl and beds of rock - - - - - | 28 0 | 40 0 |
| Hard limestone - - - - - | 184 0 | 224 0 |

Staveley.

Well at Loftus Hill.
(One-inch Map 93, N.W., N.S. 62; six-inch Map 138, S.W.)

| | Thickness. | Depth. |
|--|------------|---------|
| | Ft. in. | Ft. in. |
| Red earthy clay - - - - - | 12 0 | 12 0 |
| Broken limestone getting stronger towards bottom - - - - - | 66 0 | 78 0 |
| Red grit like that of Knaresborough | | |

ALLERTON HALL.

Gravel, 25 yards.

ARKENDALE.

Clay, 30 feet, then gravel.

Brearton.

Well in the village.
About 175 feet above Ordnance Datum.

| | Thickness. | Depth. |
|------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Clay - - - - - | 9 0 | 9 0 |
| Gravel - - - - - | 1 2 | 10 2 |

Ingerthorpe.

Well at Mr. Ward's House, Jan. 1864.
Communicated by Rev. J. S. Tute.

| | Thickness. | Depth. |
|-----------------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Brown gravelly clay - - - - - | about 6 0 | 6 0 |
| Dark brown boulder clay - - - - - | about 39 0 | 45 0 |
| Blue Magnesian Limestone | | |

Markington.

Well in the square.

Communicated by Rev. J. S. Tute.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---|-----------------------|-------------------|
| Stiff dark-coloured boulder clay - - - - - | 21 0 | 21 0 |
| Sandy gravel with boulders included rounded pieces of Magnesian Limestone - - - - - 9 0 to | 12 0 | 33 0 |
| Magnesian Limestone | | |

Ripon.

1. Well at Mr. S. Darnborough's, Hutton Bank.

Communicated by Rev. J. S. Tute.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---|-----------------------|-------------------|
| Soil - - - - - | 0 8 | 0 8 |
| Soft sandy red rock - - - - - | 10 0 | 10 8 |
| Soft marly clay - - - - - | 0 10 | 11 6 |
| Red rock much false-bedded with layers of clay about every 10 feet - - - - - | 74 0 | 85 6 |

2. Bondgate Brewery.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---------------------------|-----------------------|-------------------|
| Sand and gravel - - - - - | 30 0 | 30 0 |
| Limestone - - - - - | 2 0 | 32 0 |

BLOWS HALL.

Red sand, 47 yards.

MARTON-LE-MOOR.

Sandstone at 70 feet.

HIGH BROOMS.

Sandstone at 75 feet.

NEWBY HALL.

Clay, 7 yards, then wick sand.

Boroughbridge.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 138.)

Well in centre of St. James Square.

From *Brit. Assoc. Rep.* for 1876, p. 107.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---|-----------------------|-------------------|
| Soft red sand and boulders - - - - - | 28 0 | 28 0 |
| New red sandstone with layers of marl 3 in. to 4 in. thick - - - - - | 228 0 | 256 0 |
| Water stands at 17 feet. Reduced 2 in. after 36 hours pumping. | | |

Brafferton.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 120.)

1. Boring at Helperby.

Communicated by Prof. Kendall.

| | Thickness. Ft. in. | Depth. Ft. in. |
|---------------------------------|-----------------------|-------------------|
| Boulder clay and sand - - - - - | 20 0 | 20 0 |
| Quicksand - - - - - | 10 0 | 30 0 |
| Fine clay - - - - - | 10 0 | 40 0 |
| Gravel - - - - - | 15 0 | 55 0 |
| Sandstone - - - - - | | |

Brafferton—(*continued*).

2. Boring at Pill Moor.

Communicated by Mr. T. Owston.

| | Thickness. | Depth. |
|-------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Soil and sand - - - - - | 3 0 | 3 0 |
| Clay - - - - - | 115 0 | 118 0 |

Sessay.

Sand, 7 yards.

Myton.

Sand, 10 yards.

Raskelf.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 121.)

1. Spring House.

Communicated by Mr. T. Owston.

| | Thickness. | Depth. |
|--------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Boulder clay - - - - - | 60 0 | 60 0 |
| Freestone rock - - - - - | 145 0 | 205 0 |

Water rises within 6 feet of the top.

2. Boring near the railway station.

From *Rep. Yorksh. Phil. Soc.* for 1893, p. 57.

| | Thickness. | Depth. |
|------------------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Sand - - - - - | 0 10 | 10 10 |
| Boulder clay - - - - - | 50 0 | 50 10 |
| Shale [Marl] with gypsum - - - - - | 15 0 | 65 10 |
| Red shale - - - - - | 41 0 | 106 10 |
| Grey sandstone - - - - - | 45 0 | 151 10 |
| Blue shale - - - - - | 10 0 | 161 10 |

Huby.

(One-inch Maps, 93, N.W., N.E., N.S. 62, 63; six-inch Maps 139, 140.)

From *Rep. Yorksh. Phil. Soc.* for 1893, p. 57.

| | Thickness. | Depth. |
|---|------------|---------|
| | Ft. in. | Ft. in. |
| Soil - - - - - | 1 6 | 0 6 |
| Stony clay - - - - - | 12 0 | 13 6 |
| Clay with sand partings - - - - - | 12 0 | 25 6 |
| Red clay with seams of gypsum - - - - - | 80 0 | 105 6 |
| Green marl with thin seams of sandstone - - - - - | 4 0 | 109 6 |

2. Huby Burn Farm.

From *Rep. Yorksh. Phil. Soc.* for 1893, p. 56.

| | Thickness. | Depth. |
|----------------------------------|------------|---------|
| | Ft. in. | Ft. in. |
| Soil - - - - - | 1 6 | 1 6 |
| Brown clay - - - - - | 10 0 | 11 6 |
| Plastic clay - - - - - | 8 0 | 19 6 |
| Solid blue clay - - - - - | 4 0 | 23 6 |
| Boulder clay - - - - - | 12 0 | 35 6 |
| Red marl with gypsum seams | 31 0 | 66 6 |
| Green marl - - - - - | | |
| Grey sandy marl - - - - - | | |
| Red sandy clay - - - - - | | |
| Red marl - - - - - | | |
| Red sandy marl - - - - - | | |
| Red marl with gypsum - - - - - | | |
| Green marl with gypsum - - - - - | | |
| Brown marl with gypsum - - - - - | | |
| Red sandy marl - - - - - | | |

Newton-on-Ouse.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 156.)
 Communicated by Mr. J. Villiers. Also in Kaye's Report.
 Well sunk, March, 1888.

| | Thickness. Ft. in. | Depth. Ft. in. |
|------------------------------|-----------------------|-------------------|
| Top soil - - - - - | 1 0 | 1 0 |
| Red clay - - - - - | 3 0 | 4 0 |
| Warp - - - - - | 7 0 | 11 0 |
| Sand - - - - - | 25 0 | 36 0 |
| Sand and warp - - - - - | 20 0 | 56 0 |
| Warp clay - - - - - | 16 0 | 72 0 |
| Yellow clay - - - - - | 1 0 | 73 0 |
| Light sandstone - - - - - | 17 0 | 90 0 |
| Soft red sandstone - - - - - | 24 6 | 114 6 |
| Red marl - - - - - | 0 6 | 115 0 |
| Soft sandstone - - - - - | 105 0 | 220 0 |

Water level, 32 feet from surface.

Cattal.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 172.)
 At the Inebriates' Home, 1903.
 From Kaye's Report.

| | Thickness. Ft. in. | Depth. Ft. in. |
|------------------------|-----------------------|-------------------|
| Soil - - - - - | 1 0 | 1 0 |
| Boulder clay - - - - - | 17 0 | 18 0 |
| Sandstone - - - - - | 184 0 | 202 0 |

Kirk Hammerton.

(One-inch Map 93, N.W., N.S. 62; six-inch Map 156.)
 Well at the Railway Station.

| | Thickness. Ft. in. | Depth. Ft. in. |
|----------------------------|-----------------------|-------------------|
| Superficial beds - - - - - | 24 0 | 24 0 |
| Red sandstone - - - - - | — | — |

Thirsk

(One-inch Map 96, S.W., N.S. 52; Six-inch Map 87, S.E.)
 Boring at the Brewery, 1877.
 Communicated by Mr. J. T. Hymas.

| | Thickness. Ft. in. | Depth. Ft. in. |
|--|-----------------------|-------------------|
| Sand - - - - - | 6 0 | 6 0 |
| Clay - - - - - | 4 3 | 10 3 |
| Gravel with water - - - - - | 6 9 | 17 0 |
| Stony clay - - - - - | 5 10 | 22 10 |
| Sand and gravel - - - - - | 4 3 | 27 1 |
| Brown strong clay - - - - - | 3 1 | 30 2 |
| Red shale - - - - - | 1 6 | 31 8 |
| Grey shale - - - - - | 18 10 | 50 6 |
| Soft red marl - - - - - | 3 0 | 53 6 |
| Red and grey marl - - - - - | 5 0 | 58 6 |
| Grey shale and girdles with water - - - - - | 5 6 | 64 0 |
| Red and grey shale - - - - - | 6 6 | 70 6 |
| Shale and gypsum - - - - - | 10 6 | 81 0 |
| Grey metal and gypsum - - - - - | 3 6 | 84 6 |
| Red shale and gypsum - - - - - | 6 7 | 91 1 |
| Grey shale and girdles with gypsum - - - - - | 8 5 | 99 6 |
| Red shale and gypsum - - - - - | 52 6 | 152 0 |
| Grey shale and gypsum - - - - - | 10 0 | 162 0 |
| Red shale and gypsum - - - - - | 10 0 | 172 0 |
| Grey shale and gypsum - - - - - | 3 2 | 175 2 |
| Strong red shale with hard girdles - - - - - | 18 0 | 193 2 |

Thirsk—(continued.)

| | Thickness. Ft. in. | Depth. Ft. in. |
|--|-----------------------|-------------------|
| Hard grey post - - - - - | 6 5 | 199 7 |
| Red shale and gypsum with water - - - - - | 29 4 | 228 11 |
| Red shale and freestone girdles - - - - - | 13 0 | 241 11 |
| Strong shale and freestone girdles - - - - - | 20 1 | 262 0 |
| Shale and gypsum with water - - - - - | 2 11 | 264 11 |
| Grey shale and gypsum - - - - - | 15 0 | 279 11 |
| Red shale and grey post with water - - - - - | 11 0 | 290 11 |
| Soft red freestone - - - - - | 10 9 | 301 8 |
| Strong red freestone - - - - - | 11 3 | 312 11 |
| Soft red freestone - - - - - | 11 9 | 324 8 |
| Red freestone - - - - - | 17 0 | 341 8 |
| Red shale and freestone girdles - - - - - | 9 5 | 351 1 |
| Red freestone - - - - - | 9 6 | 360 7 |

Bedale.**LONDONDERRY.**

(One-inch Map 96, S.W., N.S. 52; six-inch Map 70 S.W.)

Communicated by Mr. J. T. Hymas.

| | Thickness. Ft. in. | Depth. Ft. in. |
|------------------------------------|-----------------------|-------------------|
| Clay and sand with water - - - - - | 36 0 | 36 0 |
| Red sandstone - - - - - | 60 0 | 96 0 |

Water is drawn from the red sandstone.

BEDALE HALL.

| | | |
|--------------------------------------|-------|-------|
| Sand and gravel with water - - - - - | 18 0 | 18 0 |
| Boulder clay - - - - - | 144 0 | 162 0 |
| Sandy limestone - - - - - | 38 0 | 200 0 |

Water level 80 feet below surface. Water is drawn entirely from the limestone bed.

LEEMING BAR.

| | Boring at Mr. Langstaffs. | Thickness. Ft. in. | Depth. Ft. in. |
|--------------------------------------|---------------------------|-----------------------|-------------------|
| Sand and gravel with water - - - - - | - | 20 0 | 20 0 |
| Boulder clay - - - - - | - | 20 0 | 40 0 |
| Red sandstone and red marl - - - - - | - | 20 0 | 60 0 |
| Red marl - - - - - | - | 83 0 | 143 0 |

Water is drawn from the red sandstone.

Masham Moor.

(One-inch Map 97, S.E., N.S. 51; six-inch Map 100 N.E.)

Boring 400 yards S.E. of the Pott Beck at Fair Thorn. About 850 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | Thickness. Ft. in. | Depth. Ft. in. |
|--|-----------------------|-------------------|
| Sandy soil - - - - - | 7 0 | 7 0 |
| Brown shale - - - - - | 4 0 | 11 0 |
| Hard grey rock - - - - - | 10 0 | 21 0 |
| Brown shale - - - - - | 12 0 | 33 0 |
| Blue shale (block) - - - - - | 54 0 | 87 0 |
| Hard blue grey rock - - - - - | 8 0 | 95 0 |
| Brown shale - - - - - | 0 6 | 95 6 |
| Hard blue grey rock - - - - - | 3 0 | 98 6 |
| Brown shale - - - - - | 4 0 | 102 6 |
| Yellow sandstone - - - - - | 10 0 | 112 6 |
| Hard brown rock - - - - - | 3 0 | 115 6 |
| Hard brown shale - - - - - | 10 0 | 125 6 |
| Yellow clay - - - - - | 0 9 | 126 3 |
| Hard brown rock (much jointed) - - - - - | 5 9 | 132 0 |
| Dark blue shale - - - - - | 16 0 | 148 0 |
| Very hard grey rock - - - - - | 8 4 | 156 4 |
| Blue and grey rock and shale - - - - - | 12 0 | 168 4 |
| Yellow sandstone - - - - - | 10 6 | 178 10 |

Masham Moor—(continued).**ROUNDHILLS RESERVOIR.**

Section in embankment trench, S. end.

Top water level 743. Stream level 630 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon,

| | Thickness Ft. in. | Depth. Ft. in. |
|--|----------------------|-------------------|
| Yellow sandstone - - - - - | 37 0 | |
| Brown shale - - - - - | 34 0 | |
| Hard grey rock - - - - - | 12 0 | to 18 0 |
| Blue stratified shale - - - - - | 14 0 | |
| Hard grey rock, stained brown 3 or 4 inches - - - - - | 2 0 | |
| Blue stratified shale - - - - - | 22 0 | |
| Thin bed of rock, with shale bands - - - - - | 4 0 | |
| Blue stratified shale, with bands of sandstone thinning out - - - - - | 20 0 | |
| Blue stratified shale, with bands of rock alternating and thinning out - - - - - | 34 0 | |
| Section in embankment trench, N. end. | | |
| Yellow sandstone - - - - - | 13 0 | |
| Brown shale - - - - - | 35 0 | |
| Hard grey rock - - - - - | 12 0 | |
| Blue stratified shale with band of rock - - - - - | 30 0 | |
| Hard grey rock, upper part much broken with few thin shale bands - - - - - | 79 0 | |

Kirkby Malzeard.

(One-inch Map 97, S.E., N.S. 51; six-inch Map 101 S.W.)

Boring on Grewelthorpe Moor. On the S. side of the stream flowing from Sandwith Wham and 430 yards S.W. of Stock Beck. About 875 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | Thickness. Ft. in. | Depth. Ft. in. |
|-----------------------------|-----------------------|-------------------|
| Alluvium (Drift?) - - - - - | 49 0 | 49 0 |
| Blue shale - - - - - | 27 0 | 76 0 |
| Grey sandstone - - - - - | 120 0 | 196 0 |
| Blue shale - - - - - | 21 0 | 217 0 |

Boring 930 yards S.E. of the above, and about 1,000 yards nearly W. of Bagwith House. About 800 feet above Ordnance Datum.

Communicated by Mr. F. J. Dixon.

| | Thickness Ft. in. | Depth. Ft. in. |
|--------------------------|----------------------|-------------------|
| Boulder clay - - - - - | 5 6 | 5 6 |
| Blue shale - - - - - | 26 0 | 31 6 |
| Grey sandstone - - - - - | 61 0 | 92 6 |
| Blue shale - - - - - | 9 0 | 101 6 |
| Grey sandstone - - - - - | 12 0 | 113 6 |
| Blue shale - - - - - | 30 0 | 143 6 |

APPENDIX II.

BIBLIOGRAPHY.

List of Works relating to the Geology and Mineral Waters of the District with the exception of purely medical works.

Titles marked with an asterisk are taken from other bibliographies, but have not been verified.

LIST OF AUTHORS.

The figures refer to date of publication, those in brackets indicating the Maps and Sections of the Geological Survey.

- | | |
|--------------------------------------|---------------------------------------|
| Ackroyd, W. 1901. | Breare, W. H. 1891. |
| Adamson, S. A. 1885. | Briggs, H. 1846. |
| Airy, Dr. H. 1885. | Britton, T. 1888. |
| Akerman, J. Y. 1847. | Brown, R. 1794. |
| Alexander, W. 1773. | Buchan, Dr. W. 1786. |
| Allen, B. 1699, 1711. | Burrell, B. A. 1896, 1897 1898. |
| Allen, T. 1828. | |
| Althaus, J. 1862. | Calvert, M. 1823, 1844. |
| Anon. 1770, 1793, 1806, 1815, 1816, | Camden, W. 1586, 1720. |
| 1817, 1822, 1825, 1827, 1837, 1838, | Cameron, A. C. G. 1879, 1880, 1882, |
| 1839, 1840, 1843, 1846, 1858, 1889, | (1884), (1885), 1886. |
| 1891, 1898, 1900, 1901, 1905. | Carter, R. 1885. |
| — H. A. A. 1888. | Carter, W. L. 1907. |
| — W. F. B. 1895. | Cary, G. S. 1799. |
| — T. E. L. 1831. | Castro, T. de. 1756. |
| — L. E. O. 1829. | Cayley, Dr. G. 1809. |
| — T. S. 1903. | Chadwick, S. 1892. |
| — W. C. T. 1829. | Charnock, J. H. 1848. |
| Armstrong, J. L. 1877. | Church, A. H. 1866. |
| Atkins, J. 1742. | Clarke, J. E. 1889. |
| Atkinson, D. H. 1885. | Clay, J. T. 1842. |
| Atkinson, J. 1824. | Clayton, Dr. 1697. |
| Aveline, W. T. (1869), (1870), 1870, | Coleman, J. 1881. |
| 1874. | Conybeare, Rev. W. D. 1822, 1834. |
| | Cooke, G. A. 1812. |
| Bain, W. 1905. | Crosskey, H. W. 1888, 1889, 1890, |
| Baines, H. 1840. | 1893, 1894. |
| Baines, T. 1871. | Curry, J. 1867. |
| Baker, J. H. 1863, 1869. | |
| Barnes, J. 1896. | Dakyns, J. R. (1869), (1870), (1871), |
| Barrow, G. (1884), 1886. | (1872), 1872 (1874), (1875), (1876), |
| Barry, Dr. F. W. 1890. | (1878), (1879), (1882), (1885), |
| Baynard, Dr. E. 1697. | (1889), 1894. |
| Bealey, A. 1853. | Dalton, W. H. (1875), (1878), (1879), |
| Bennett, Dr. W. 1842, 1843. | (1889), 1889. |
| Bevan, G. P. 1877. | Daubeny, C. 1837. |
| Bigland, J. 1812. | Davis, J. W. 1878, 1879, 1883. |
| Binney, E. W. 1866. | Davis, R. H. 1866, 1873, 1874, 1881, |
| Bird, C. 1881. | 1884, 1885, 1889. |
| Black, A. and C. 1867. | Davison, C. 1905, 1906. |
| Black, J. Gordon. 1895, 1898. | Deane, Dr. E. 1626. |
| Blake, J. F. 1876, 1879. | De la Beche, Sir H. T. 1830. |
| Blome, R. 1673. | De Rance, C. E. 1876, 1877, 1878, |
| Booth, A. 1830. | 1882, 1891. |
| Bothamley, C. H. 1881, 1891, 1894. | Drake, F. 1736. |
| Bradshaw, B. 1882. | Durand-Fardel, M. 1857, 1860. |
| Braun, J. 1875. | Dwerryhouse, A. R. 1900. |

- Edgecombe, W. 1905.
 Elliott, Dr. J. 1781.
 Ellis, R. 1884.
 Elsdon, J. V. 1900.
 Etheridge, R. 1875.
 Fairley, T. 1874, 1881, 1898.
 Farey, J. 1812, 1823.
 Fitton, Dr. W. H. 1832.
 Fletcher, J. S. 1899.
 Floyer, Sir J. 1697, 1699.
 French, Dr. J. 1652, 1760.
 Fuller, T. 1662.
 Gairdner, Dr. M. 1832.
 Gale, T. 1709.
 Garnett, Dr. T. 1791.
 Garrod, A. E. 1895.
 Gascoigne, R. 1880.
 Geikie, J. 1874.
 Geological Survey (1896).
 George, E. S. 1827.
 Gibson, E. 1886.
 Glover, R. M. 1857.
 Goodchild, J. G. (1879).
 Gough, R. 1586.
 Grainge, W. 1859, 1861, 1862, 1863,
 1864, 1865, 1871, 1891.
 Grange, W. D'Oyly. 1899.
 Granville, A. B. 1841.
 Green, A. H. 1870, 1872 (1876),
 1878.
 Greenough, G. B. 1866.
 Greenwell, A. 1900.
 Grim, H. No date.
 Gunn, W. (1878), (1879).
 Hardwicke, H. J. 1883.
 Hargrove, E. 1769.
 Harmer, F. W. 1907.
 Harrison, W. J. 1878, 1882.
 Harrogate Sewerage Scheme. 1902.
 Hawkesworth, E. 1903.
 Hearne, T. 1710.
 Henderson, T. F. 1888.
 Heywood, A. No date.
 Higgins, Dr. 1788.
 Hind, W. 1901, 1902, 1907.
 Hinde, G. J. 1887.
 Hirschfeld, J. 1875.
 Hobkirk, C. P. 1874.
 Hoffmann, F. 1731.
 Hofmann, A. W. 1854, 1855.
 Holgate, B. 1885, 1888, 1889, 1900.
 Holland, T. P. 1586.
 Hollins, T. 1858.
 Holroyd, W. F. 1896.
 Howarth, J. H. 1900, 1902, 1903,
 1904, 1905, 1908.
 Howell, H. H. (1884.)
 Hudleston, W. H. 1883, 1898.
 Hull, E. 1862, 1868, 1879, 1880,
 1882.
 Hunter, Dr. Adam. 1806, 1819, 1830.
 Hunter, Rev. J. 1830.
 Inchbold, T. 1828.
 Ingle, H. 1881.
 Ingram, D. 1773.
 James, P. 1883.
 Jaques, J. 1791.
 Johns, C. 1905, 1906.
 Johnson, Dr. J. 1843.
 Johnstone, M. M. 1881.
 Jones, T. Rupert. 1865.
 Kaye, J. R. 1904.
 Kendall, P. F. 1892, 1893, 1894,
 1895, 1896, 1898, 1900, 1902, 1903,
 1904, 1905, 1907.
 Kennedy, C. L. 1881.
 Kennion, Dr. G. 1845, 1853, 1858.
 Kirkby, J. W. 1861.
 Kirwan, R. 1799.
 Knowlton, T. 1746.
 Lamplugh, G. W. 1901, 1907.
 Langdale, W. 1845.
 Lavis, H. J. Johnston. 1892.
 Lebour, G. A. 1875.
 Leech, D. J. 1901.
 Lee, E. 1834, 1841, 1848.
 Lees, F. A. 1878, 1888, 1901.
 Leigh, C. 1694, 1697.
 Leland, J. 1710.
 Lewis, A. L. 1879.
 Lewis, H. C. 1887, 1894.
 Lewis, S. 1849.
 Liddell, Dr. J. 1893.
 Lister, Dr. M. 1684, 1686.
 Lockyer, Sir Norman. 1908.
 Lucas, C. 1757.
 Lucas, J. (1870), (1871), 1872,
 (1875), (1876), (1877), (1878) (1879),
 1882, (1889.)
 Lucas, W. 1845.
 Mackenzie, Dr. P. 1819.
 Mackintosh, D. 1865, 1866, 1871,
 1880.
 Macpherson, Dr. J. E. 1869, 1871.
 Manson, D. 1869.
 Marr, J. E. 1887.
 Marshall, W. 1788, 1808, 1826.
 Miall, L. C. 1873.
 Milburn, M. M. 1848.
 Miles, C. E. 1884.
 Mill, H. R. 1904.
 Miller, J. 1821.
 Mitchell, C. A. 1901.
 Mitchell, T. C. 1890.
 Monro, Dr. Alex. 1760.
 Monroe, Dr. D. 1770, 1773.

- Morris, M. 1895.
 Murchison, Sir R. I. 1867.
 Murray, Dr. J. 1815, 1817.
 Muspratt, Dr. S. 1864, 1865, 1866,
 1867, 1868, 1869.
 Myrtle, Dr. A. S. 1867, 1870, 1895.
 Neale, G. 1734.
 Oliver, Dr. G. 1881, 1885.
 Osann, E. 1829.
 Owen, W. 1752.
 Palliser, P. 1840.
 Paul, G. 1899, 1900.
 Pennant, T. 1804.
 Penrose, F. 1895.
 Phillips, J. 1827, 1828, 1829, 1831,
 1833, 1836, 1837, 1840, 1853, 1854,
 1855, 1863, 1865, 1875.
 Phillips, W. 1822.
 Pickler, W. 1875.
 Piggott, Dr. G. W. 1853, 1854.
 Platnauer, H. M. 1888, 1889, 1894,
 1901.
 Ramsay, Sir A. C. 1872.
 Rankin, W. M. 1903.
 Reade, T. M. 1883, 1896.
 Rennie, G. 1794.
 Reports, 1837, 1861.
 Reynolds, R. 1896.
 Roberts, A. 1893, 1894, 1901.
 Rooke, H. 1787.
 Rotureau, A. 1864.
 Rücker, A. W. 1890, 1891.
 Russel, Dr. R. 1752.
 Russell, A. G. 1892.
 Russell, R. (1870), 1870 (1876) (1878)
 1878.
 Rutt, Dr. J. 1757, 1758, 1760.
 Sabine, Sir E. 1870.
 Sanders, Dr. W. 1800.
 Scudamore, Dr. C. 1820.
 Sedgwick, A. 1825, 1827, 1829.
 Shaw, P. 1731.
 Sheahan, J. J. 1855, 1871.
 Shirreff, J. 1794.
 Short, Dr. T. 1709, 1734, 1765,
 1766.
 Simpson, Dr. W. 1669, 1670, 1675.
 Smith, A. 1840, 1842.
 Smith, C. H. 1840, 1844.
 Smith, F. W. 1899.
 Smith, H. E. 1852.
 Smith, W. 1815, 1820, 1821.
 Smith, W. G. 1903.
 Sorby, H. C. 1859.
 Sowerby, J. 1804, 1829.
 Speight, H. 1894.
 Spence, J. 1844.
 Squire, Dr. N. 1888.
 Stanhope, Dr. M. 1626, 1632.
 Strangways, C. Fox-. (1869), (1870),
 (1871), (1872), (1874), 1874, (1875),
 (1876), (1878), (1882), (1884), 1884,
 (1885), 1885, 1886, (1889), 1896.
 Stukeley, W. 1724.
 Sugden, S. 1870.
 Summerfield, Rev. R. A. 1888.
 Swain, W. T. 1893.
 Sweeting, R. D. B. 1885.
 Tait, M. 1888.
 Tate, A. 1888.
 Tate, R. 1876.
 Tate, T. 1893, 1894, 1895.
 Taylor, J. 1626.
 Teall, J. J. H. 1880.
 Tennant, S. 1799.
 Tichborne, T. R. C. 1883.
 Tiddeman, R. H. (1889).
 Thompson, T. W. 1893.
 Thoresby, R. 1715, 1830.
 Thorpe, J. 1866. No date.
 Thorpe, T. E. 1876, 1881, 1890, 1891.
 Thorpe, W. 1840, 1841, 1843, 1849,
 1853.
 Thresh, J. C. 1896.
 Tooke, A. W. 1837.
 Tuke, J. 1794.
 Tute, Rev. J. S. 1866, 1868, 1870,
 1873, 1878, 1879, 1884, 1886, 1890,
 1892, 1893.
 Vaughan, A. 1906.
 Vine, G. R. 1885.
 Walbran, J. R. 1841, 1844.
 Walker, Dr. J. 1770, 1784.
 Ward, J. C. 1869, (1870), (1871),
 1872, (1875), (1876).
 Waring, E. J. 1878.
 Watson, R. 1786, 1787.
 Weatherhead, W. 1839.
 Weber, F. P. 1896, 1898, 1907.
 Weber, H. 1882, 1896, 1898, 1907.
 West, W. 1823, 1831, 1845.
 Wheeler, W. 1891.
 Whellan, T. 1855.
 Whitaker, W. 1875.
 White, W. H. 1901.
 Whiteley, R. L. 1885.
 Willan, Dr. R. 1782.
 Williams, J. W. 1820.
 Wilson, A. E. 1881.
 Wilson, E. 1876, 1879, 1880, 1881.
 Wilson, J. H. 1882.
 Winch, N. J. 1816, 1822.
 Wittie, R. 1699.
 Wood, J. 1760.
 Wood, S. V. 1870, 1871, 1872, 1880.
 Woodward, H. 1906.
 Woodward, H. B. 1876.
 Wright, G. F. 1892.
 Yeo, J. B. 1885, 1904.

1586. CAMDEN, W. *Britannia sive florentissimorum regnorum Angliæ, Scotiæ, Hiberniæ, et Insularum adiacentium et intima antiquitate Chorographica descriptio*. [Knaresborough, p. 403, Devil's Arrows, Boroughbridge, p. 406.] 16mo. *London*. Another Ed. 8vo. *London*, 1587. Ed. 3. 8vo. *London*, 1590. German, 8vo. *Frankfurt*, 1590. Ed. 4. 4to. *London*, 1600. Another Ed. Fol. *London*, 1607. Another Ed. 8vo. *Frankfurt*, 1616. Also many later editions by T. P. HOLLAND, E. GIBSON and R. GOUGH.
1626. DEANE, Dr. E. *Spadacrene Anglica, or the English Spaw-Fountain. Being a Briefe Treatise of the acide or tart Fountain in the Forest of Knaresborow in the West-Riding of Yorkshire. As also a Relation of other medicinall Waters in the said Forest*. Pp. 32. 4to. *London*. Ed. 2. 1649, under different title, with additions by JOHN TAYLOR. Pp. 39. 4to. *York*. Ed. 3. 1654, 12mo. *York*. Reprinted with additional observations, by M. STANHOPE and others, under the title '*Spadacrene Anglica*'; or the English Spaw. Being an account of the Situation, Nature . . . and admirable Cures performed by the Waters of Harrogate, and Parts adjacent, and also The Observations of the ingenious Dr. Stanhope . . . Pp. 41. 8vo. *Leeds*, 1736.
- STANHOPE, Dr. MICHAEL. *Newes out of York-Shire, or an Account of a journey in the true discovery of a Sovereigne Minerall Medicinall Water, in the West Riding of Yorke-shire, neare an ancient Towne called Knaresbrough, not inferiour to the Spa in Germany*. 4to. *London*. Another Ed. Pp. 30. 1627. 4to.
1632. STANHOPE, Dr. M. *Cures without Care, or a summons to all such as finde little or no helpe by the use of Physick, to repaire to the Northerne Spaw; wherein by many presidents of a few late yeares, it is evidenced to the world, that infirmities, of their owne nature desperate, and of long continuance, have received perfect recovery by vertue of Minerall waters neare Knaresborow in the West-riding of Yorkshire. Also a description of the said water, and of other rare and usefull springs adjoining, the nature and efficacye of the Minerals contained in them, with other not impertinent notes*. 4to. *London*.
- A Relation of certain particular cures, done by vertue of Minerall waters neare Knaresborow in the West-riding of the county of Yorkshire. 4to. *York*. Another Ed. 4to. *York*, 1649. Another Ed. 8vo. 1654. Reprinted as second part of Dr. Dean's *Spad. Ang.* 8vo. *Leeds*, 1736.
1652. FRENCH, Dr. J. *The York-shire Spaw: or a treatise of four Famous Medicinal Wells, viz., the Spaw or Vitrioline-Well; the stinking, or Sulphur-Well; the Dropping, or Petrifying-Well; and St. Magnus-Well near Knaresborow in York-shire; together With the causes, virtues and use thereof*. [Long dissertation on the origin of the springs.] 12mo. *London*. Another Ed. Pp. 124. 1654. Reprinted under the title '*A pocket companion for Harrowgate Spaw*.' 12mo. *Halifax*, 1760.
1662. FULLER, T. *The History of the Worthies of England*. [Medicinal Waters, Pt. iii., pp. 188, 189.] Fol. *London*.
- 1669 SIMPSON, Dr. W. *Hydrologia Chymica: or, The Chymical Anatomy of the Scarbrough and other Spaws in York-Shire. Wherein are interspersed Some Animadversions upon Dr. Wittie's lately Published Treatise of the Scarbrough-Spaw. Also, a short Description of the Spaws at Malton and Knaresbrough. [The Sweet Spaw and the Sulphur Well at Harrogate, pp. 136-147.]* 8vo. *London*. Abstract and review in *Phil. Trans.* vol. i., No. 42, pp. 850-852; No. 51, pp. 1037-1040.

1670. SIMPSON, Dr. W. *Hydrological Essays : or, a Vindication of Hydrologia Chymica : Being a further Discovery of the Scarbrough Spaw and of the right use thereof, and of the Sweet Spaw and Sulphur Well at Knaresborough : with a brief Account of the Allom Works at Whitby.* 12mo. *London.*
1673. BLOME, R. *Britannia or a Geographical Description of the Kingdoms of England, Scotland, and Ireland with the Isles and Territories thereto belonging . . .* [Knaresborough Wells, p. 259]. Fol. *London.*
1675. SIMPSON, Dr. W. *A Discourse of the Sulphur-Bath at Knaresborough in York-shire.* Pp. 28. 12mo. *London.*
 — *Zymologia Physica, or a brief Philosophical Discourse of Fermentation, From a new Hypothesis of Acidum and Sulphur . . . With an additional Discourse of the Sulphur bath at Knaresborough.* 12mo. *London.*
- 1684 LISTER, DR. MARTIN. *De Fontibus Medicatis Angliæ Exercitatio Nova et Prior.* [Alludes to Knaresborough and Harrogate, pp. 26, 28, 30, 45, 57, 62.] Pp. 64. 12mo. *Frankfort and Leipsic.* Another Ed. 12mo. *Leyden*, 1686. (? Earlier edition 4to. *York*, 1682.)
 — *An Ingenious Proposal for a new sort of Maps of Countries, together with Tables of Sands and Clays, such chiefly as are found in the North parts of England, drawn up about 10 years since, and delivered to the Royal Society, March 12, 1683.* *Phil. Trans.* vol. xiv., No. 164, pp. 739-746, and duplicate pp. 737, 738.
1686. LISTER, DR. MARTIN. *Exercitationes et Descriptiones Thermarum ac Fontium Medicatorum Angliæ. Eorum originem, salubrem usum et potationis modum tradentes.* [Knaresborough and Harrogate, pp. 26, 29, 32, 53.] Pp. 156. 12mo. *Leyden.* Another Ed. 12mo. 1689. Partly a reprint of 'De Fontibus' 1684.
1694. LEIGH, C. *Phthisiologia Lancastriensis, cui accessit Testamen Philosophicum de Mineralibus Aquis In eodem Comitatu Observatis* [Knaresborough, pp. 114, 136 ; Harrogate, p. 126]. 12mo. *London.*
1697. FLOYER, Sir JOHN. *An Enquiry into the Right Use and Abuses of the Hot, Cold, and Temperate Baths in England.* [Pp. 113-117, A Letter from Dr. CLAYTON concerning the Virtues of St. Mungus' Well near Knaresborough in Yorkshire.] Pp. 144. 8vo. *London* ; Ed. 2. 'Ancient Psychrolusy revived,' 1702 ; Ed. 3. *History of Hot and Cold Bathing, Ancient and Modern ; with an Appendix by Dr. E. BAYNARD.* 8vo. *London*, 1702, 1706, 1709, 1715, 1722 (styled Eds. 1-5) ; Latin, 12mo. *Leyden*, 1699 ; German, 8vo. *Breslau*, 1729.
- LEIGH, C. *Exercitationes quinque. De Aquis Mineralibus, Thermis Calidis, Morbis Acutis, Morbis Intermittentib ; Hydrope.* [Knaresborough Springs.] 12mo. *Oxford.*
1699. ALLEN, B. *The Natural History of the Chalybeate and Purging Waters of England, with their particular Essays and Uses . . .* [Knaresborough, pp. 19, 20.] 8vo. *London.*
1699. FLOYER, Sir J. *Inquisitio in verum Usum and Abusum calidorum, frigidorum, et temperatorum Angliæ balneorum.* [Pp. 258-261, Literæ D. D. Claytonii concernentes virtutes Scaturiginis St. Mungi prope Knaresborouhum in agro Eboracensi.] Impr. in Nicolaus Vallerius. *Testamina Physico-Chymica circa Aquas Thermales Aquisgranensis.* Pp. 282. 8vo. *Leyden.*
- WITTIE, Dr. R. *Pyrologia Mimica, or An Answer to Hydrologia Chymica of William Simpson, Phylo-chymico-medicus ; In Defense of Scarbrough-Spaw . . .* [Knaresborough Springs, pp. 122-177.] 16mo. *London.*
1709. GALE, T. *Antonini iter Britanniarum Commentariis Illustratum* [Devil's Arrows at Boroughbridge, p. 17.] 4to. *London.*
 *SHORT, Dr. T. *Memoirs of the Natural History of Medicinal Waters* 8vo. *London.*

- 1710-1712. HEARNE, T. The Itinerary of John Leland the Antiquary. Published from the Original MS. in the Bodleian Library (1534). [Devil's Arrows at Boroughbridge, fol. 101 ; Dropping Well at Knaresborough, fol. 103.] 9 vols. 8vo. *Oxford*. Ed. 2, 9 vols. 8vo. *Oxford*, 1744. Ed. 3. 1770.
1711. ALLEN, B. The Natural History of Mineral Waters of Great Britain. [Knaresborough Springs, pp. 31 and 40.] 8vo. *London*. Partly a reprint of that in 1699.
1715. THORESBY, RALPH. Ducatus Leodiensis: or the Topography of the Ancient and Populous Town and Parish of Leedes, and parts adjacent in the West-Riding of the County of York. [Ancient Ironstone workings in the Forest of Knaresborough, p. 106.] Fol. *London*.
- 1720-1731. CAMDEN, W. Magna Britannia et Hibernia, Antiqua et Nova, or A New Survey of Great Britain, wherein to the Topographical Account given by Mr. Cambden and the late Editors of his Britannia, is added a more large History, not only of the Cities, Boroughs, Town, and Parishes mentioned by them, but also of many other Places of Note and Antiquities since discovered. [Boroughbridge and Knaresborough, vol vi., pp. 374, 375.] 6 vols. 4to. *London*. Original latin edition, 1551-1623.
1724. STUKELEY, W. Itinerarium Curiosum: or An Account of the Antiquities and remarkable curiosities in nature or art, observed in travels through Great Britain. [Devil's Arrows at Boroughbridge, vol. ii., p. 74.] 2 vols. Fol. *London*.
1731. * HOFFMANN, F. Experiments and observations upon Mineral Waters, with notes by PETER SHAW. 8vo. *London*. Ed. 2 [1743].
1734. NEALE, G. Spadacrene Eboracensis: Or the Yorkshire Spaws, near Knaresburgh: Being a description of Five famous Medicinal Wells, viz.: 1, The Sweet Spaw; 2, The Sulphur, or stinking Well; 3, The Dropping Well; 4, The Black Spring, found out by the author; 5, St. Magnus's or St. Mungo's Well. All which Wells, with their Situation, Operation, Virtues, &c., are described. Together with the Hot and Cold Baths; as likewise Fume-Baths. [A portion published posthumously by Dr. Short, vol. i., pp. 286-293. This was written in 1656 but not published. "A mutilated copy of the MS. was given by his widow to Dr. Short, which was introduced by way of notes in that author's work." Calvert, 1831, p. 31.]
- SHORT, Dr. T. The Natural Experimental, and Medicinal History of the Mineral Waters for Derbyshire, Lincolnshire and Yorkshire, particularly those of Scarborough . . . Together with the Natural History of the Earths, Minerals and Fossils through which the chief of them pass. [Knaresborough Dropping Well, pp. 105, 106; Harrogate Waters, pp. 237-266, 285-296.] 2 vols. 4to. *London* and *Sheffield*. Vol. ii., 1740
1736. DRAKE, F. Eboracum: or the History and Antiquities of the City of York . . . [Devil's Arrows at Boroughbridge, Plumpton Rocks and building-stones, pp. 25-29.] Fol. *London*.
- STANHOPE, DR. M. See Deane, 1626; and Stanhope, 1632.
1740. SHORT, T. An Essay Towards a Natural, Experimental and Medicinal History of the Principal Mineral Waters of Cumberland, Northumberland, Westmoreland, Bishop-prick of Durham, Lancashire, Cheshire, Staffordshire, Shropshire, Worcestershire, Gloucestershire, Warwickshire, Northamptonshire, Leicestershire and Nottinghamshire. Particularly those of Neville Holt, Cheltenham, Weatherslach, Hartlepool, Astrope, Cartmell, &c. . . . [Harrogate Sulphur Well, p. 141; Dropping Well and Sweet Spaw, p. 148.] 4to. *Sheffield*. Being the second volume of the Mineral Water of England. Vol. i., 1734.

1742. ATKINS, J. A Dissertation on the Contents, Virtues, and Uses of Cold and Hot Mineral Springs. Being pp. 312-350 of The Navy Surgeon; or Practical System of Surgery . . . [Alludes to Harrogate.] 8vo. *London*.
1746. KNOWLTON, J. An Account of Two extraordinary Deer's Horns, found underground in different parts of Yorkshire. [At Cowthorpe.] *Phil. Trans.*, vol. xliv., No. 479, pp. 124-127.
1752. RUSSEL, Dr. R. A Dissertation on the Use of Sea Water, 8vo. *Oxford*. Ed. 4, 1760, to which is added an Account of the Nature, Properties and Uses of all the remarkable Mineral Waters of Great Britain, by W. OWEN. [Harrogate, pp. 272, 273; Knaresborough, pp. 301, 302, misprinted 330.] 12mo. *London*. Ed. 5, 8vo. *London*, 1769.
1756. *CASTRO, T. DE. On the use and abuse of Mineral Waters in England. (In Italian), 8vo. *London*.
1757. LUCAS, C. An Analysis of Dr. Rutty's Methodical Synopsis of Mineral Waters. [Harrogate sulphur water, p. 37.] Pp. 101, 8vo. *London*.
- RUTTY, Dr. J. A Methodical Synopsis of Mineral Waters, comprehending The Most celebrated Medicinal Waters Both Cold and Hot of Great Britain, Ireland, France, Germany, and Italy, and several other parts of the World. [Harrogate and Knaresborough Wells, pp. 197 and 477.] Pp. 660, 4to. *London*; 8vo. *Dublin*, 1757; Ed. ? 1761; Ed., 4to., 1767.
1758. RUTTY, Dr. J. A Free and Candid Examination of a Pamphlet, intituled, An Analysis of Dr. Rutty's Methodical Synopsis of Mineral Waters. [Harrogate, p. 10.] Pp. 50. 8vo. *London*.
1760. FRENCH, Dr. J. A Pocket Companion for Harrowgate Spaw, or, a particular Account of the several Medicinal Springs at, or near, that Place. Shewing Their different Nature and Uses towards restoring Health and Strength. With Directions how to Use the Waters with Advantage. Pp. 56. 12mo. *Halifax*. Published originally by Dr. J. French, now revised by J. Wood.
- *MONRO, Dr. ALEX. Treatise on Mineral Waters. 2 vols. 8vo. *London*
- RUTTY, Dr. J. Thoughts on the different Impregnation of Mineral Waters; more particularly on the Existence of Sulphur in some of them. [Mentions Bilton and Harrogate.] *Phil. Trans.* for 1759, p. 392.
1765. ANON [SHORT, Dr. T.] A General Treatise on various Cold Mineral Waters in England, But more particularly on those at Harrogate, Thorpe-arch, Dorsthill, Wigglesworth, Nevill-holt and others of the like Nature, with their principal virtues and uses. Pp. viii., 248. 8vo. *London*.
1766. SHORT, Dr. T. Institutes: or an Introduction to the Examination of Mineral Waters, proposing methods for discovering their impregnating principles with greater Certainty and Exactness than has hitherto been done. [Mentions Harrogate, Malton, Scarborough, Thirsk, &c.] Pp. 194. 8vo. *London*.
- *———. Treatise on the Different sorts of Cold Mineral Waters in England. 8vo. *London*
1769. HARGROVE, E. The History of the Castle, Town, and Forest of Knaresborough, with an Account of Harrowgate and its Medicinal Waters. 12mo. *Knaresborough* and *York*. Ed. 2, 8vo., *York*, 1775. Ed. 3, Pp. 144, 12mo., *York*, 1782. Ed. 4, Pp. 330, 12mo., *York*, 1789. Ed. 5, Pp. 382, 1798. Ed. 6, Pp. 423, 12mo., *Knaresborough*, 1809. Ed. ? (called Ed. 6), 1821. Ed. 7, 1832.
1770. ANON. A Description of England and Wales, containing a particular Account of each County. Yorkshire, vol. x. [Harrogate and Knaresborough Springs, pp. 128, 129. Soils, p. 132. Devil's bolts, p. 192.] 12mo. *London*.

1770. MONRO, Dr. DONALD. A Treatise on Mineral Waters. [P. 181, Bilton; pp. 193-8, Harrogate; p. 203, Rippon; pp. 271-3, Harrogate; pp. 464-5, Knaresborough.] 2 vols. 8vo. *London*. Another Ed., 1777.
- WALKER, J. *Dissertatio Chemica Inauguralis. De Aquâ Sulphureâ Harrowgatensi.* . . . Pp. 46. 8vo. *Edinburgh*.
1773. *ALEXANDER, W. Directions for the use of Harrowgate Waters. 8vo. *Edinburgh*. Ed. 1780? 8vo. *Knaresborough and Harrogate*. Ed. 3, 1787.
- INGRAM, DALE. Experiments with a New Well-Water discovered at Epsom, and compared with Harrogate; showing their affinity, and ascertaining their contents. *Gentlemen's Magazine*, vol. xliii. pp. 125-126.
- MONRO, Dr. D. An account of the sulphureous mineral waters of Castle-Loed and Fairburn in the county of Ross; and of the salt purging waters of Pitkeathly in the county of Perth in Scotland. [These waters compared with Harrogate.] *Ibid*, pp. 284, 285.
1781. ELLIOT, Dr. J. An Account of the Nature and Medicinal Virtues of the Principal Mineral Waters in Great Britain and Ireland; and those of most repute on the Continent. [Bilton, Harrogate, Knaresborough.] 12mo. *London*. Ed. 2, 12mo. *London*, 1789.
1782. WILLAN, Dr. R. Observations on the Sulphur-Water at Croft, near Darlington. [Harrogate Water, pp. 19-25.] Pp. 56. 8vo. *London*. Ed. 2, under different title, 1786.
1784. WALKER, Dr. J. An Essay on the Waters of Harrogate and Thorparch in Yorkshire; Containing some Directions for their Use in Diseases. To which are prefixed Observations on Mineral Waters in general, and The Method of analysing them. 8vo. *London*.
1786. BUCHAN, Dr. W. Cautions concerning Cold Bathing, and drinking the Mineral Waters, being an Additional Chapter to the Ninth Edition of his Domestic Medicine. [Harrogate pp. 14, 16.] Pp. 20. 8vo. *London*. Numerous editions.
- [WATSON], R. (Bishop of Llandaff). Observations on the Sulphur Wells at Harrogate, made in July and August 1785. *Phil. Trans.*, vol. lxxvi., pp. 171-188. *Chemical Essays*, vol. v, pp. 1-42 (1787).
1787. ROOKE, H. Some account of the Brimham Rocks in Yorkshire. *Archæologia*, vol. viii., pp. 209-217, Pls. xvi., xvii. Also 4to. *London*.
- WATSON, R. Of water in a solid state; of the best spring water; and of a probable cause of the impregnation of sulphureous waters. [Harrogate, pp. 193-205.] *Chemical Essays*, vol. iii., pp. 171-205.
1788. HIGGINS, Dr. Synopsis of the Medicinal Contents of the Most Noted Mineral Waters, analysed by Dr. Higgins, at the instance of John Ellison. [First quantitative analysis.] Pp. 18. 8vo. *London*.
- MARSHALL, W. The Rural Economy of Yorkshire [Soils, &c., p. 268. Hill shaded map.] 2 vols., 8vo. *London*. Another Ed. 1818.
1791. GARNETT, Dr. T. Experiments and Observations on the Crescent Water at Harrogate. Pp. 69. 8vo. *Leeds*.
1792. GARNETT, Dr. T. A Treatise on the Mineral Waters of Harrogate, containing the History of the Waters, their Chemical Analysis, Medicinal Properties and Plain Directions for their use. Pp. 168. 8vo. *Bradforth*. Ed. 2, Pp. xii., 163, 8vo., *Leeds*, 1794. Ed. 4, with appendix by J. JAKES, *Leeds*, 1804. Ed. 5, 8vo., *Knaresborough*, 1810. Ed. 7. Pp. xii., 224. 12mo. *Knaresborough*, 1822. Ed. 8 [1829].

1793. ANON. Topographical Description of Knaresborough. [Account of the Harrogate Spaws]. *Gentleman's Magazine*, vol. lxiii., pp. 689-670.
1794. RENNIE, G., R. BROWN, and J. SHIRREFF. General View of the Agriculture of the West Riding of Yorkshire, with observations on the means of improvement. [Map and account of soils.] Pp. 140. 4to. London. Ed. 2. 8vo. 1799.
- TUKE, J. General View of the Agriculture of the North Riding of Yorkshire. [Map and account of soils.] 4to. London. Another Ed., 1800, 8vo.
1799. *CARY, G. S. The Balnea : a description of all the popular watering places, 12mo.
- KIRWAN, R. An Essay on the Analysis of Mineral Waters. [Discusses Dr. Garnett's analysis of Harrogate sulphur water, p. 137.] 8vo. London.
- TENNANT, SMITHSON. On different Sorts of Lime used in Agriculture. [Magnesian Limestone.] *Phil. Mag.*, vol. v., pp. 209-216 ; *Journ. de Phys.*, vol. li., pp. 156-163, 1800 ; also *Georgical Essays* by A. Hunter. Essay xix., vol. iv., pp. 371-385. 8vo. York, 1803.
1800. SAUNDERS, DR. W. A Treatise on the Chemical History and Medicinal Powers of some of the most celebrated Mineral Waters ; with practical remarks on the aqueous regimen. [Harrogate, pp. 405-418.] 8vo. London. Ed. 2, 1805.
1804. PENNANT, T. A Tour from Alston Moor to Harrowgate and Brimham Crags. 4to. London.
- 1804-1817. SOWERBY, J. British Mineralogy : or coloured figures intended to elucidate The Mineralogy of Great Britain. [Bilton, vol. iii., p. 67 ; Knaresborough, vol. v., p. 75.] 8vo. London.
1806. ANON. The History of Ripon : with descriptions of Studley-Royal, Fountains Abbey, Newby, Hackfall, &c., &c. An Analysis of Aldfield Spaw, and lists of the rare indigenous plants found in the neighbourhood. [Aldfield Spa and Brimham Rocks.] Ed. 2, Pp. 314, 12mo. Ripon. Ed. 1, 1801, does not refer to Aldfield.
- HUNTER, DR. ADAM. Lecture on the Sulphur Water of Harrowgate. 8vo. York.
1808. MARSHALL, W. A Review of the Reports of the Board of Agriculture ; from the Northern Department of England. [Account of soils, pp. 414-496. Map of northern counties showing main physical divisions.] 8vo. York.
1809. CAYLEY, DR. G. Synoptical Tables, showing the component parts of the Principal Mineral Waters, collected from the Works of Doctor Saunders, Doctor Garnett, Mr. Peacock of Darlington, and the late Mr. William Brunton of Ripon ; with some observations addressed to the Medical Faculty, and to the Public. 8vo. Ripon.
1812. BIGLAND J. The Beauties of England and Wales : or Original Delineations, Topographical, Historical and Descriptive of each county. [Harrogate, vol. xvi., pp. 652-655 ; Boroughbridge, p. 665.] 8vo. London.
- COOKE, G. A. Topographical and Statistical Description of the County of York, Containing an Account of its . . . Mines, Minerals . . . Being vol. xx. of "The Modern British Traveller." 16mo. London.

1812. FAREY, J. Geological Observations, in Correction of and Addition to the Paper on the Great Derbyshire Denudation, in our last, and the Report on Derbyshire, &c.; relating principally to Coal-measures near to the Chalk Strata; the Course of the 3rd and 4th Grit Rocks and Crowstone through Yorkshire and the termination of its Coal-field Northward: the Limits of the Yellow Lime Rock, and the Existence of Red Marl, Gypsum Beds, Strontian, &c., between its Rocks, &c., &c. *Phil. Mag.* vol. xxxix., pp. 93-106.
1815. ANON. The New Harrogate Guide: Being a concise Description and History of what is most remarkable in that neighbourhood, for Antiquity, Elegance, or Rural Beauty: Including Almas Cliff, Boroughbridge, Brimham Rocks, Hackfall, Knaresborough, Plumpton, &c. Pp. 135. 12mo. *Harrogate and Knaresborough*. Ed. 3, 1822. Ed. 5, 1828. Ed. 6, 1833.
- MURRAY, Dr. J. An Analysis of the Mineral Waters of Dunblane and Pitcaithly; with general Observations on the Analysis of Mineral Waters, and the Composition of Bath Water and some others. [Harrogate, p. 487]. *Trans. Roy. Soc. Edinb.*, vol. vii., pp. 445-493; *Ann. Chim.*, t. xcvi., pp. 217-288; *Ann. Phil.*, vol. vi., pp. 256-269, 347-363; *Phil. Mag.*, vol. xlv., pp. 264-278; *N. Journ. Pharm. Aerzt. Apoth. Chem.*, bd. ii., pp. 387-412 (1818).
- SMITH, W. A Delineation of the Strata of England and Wales, with parts of Scotland; exhibiting the Collieries and Mines, the Marshes and Fen Lands originally overflowed by the sea and the Varieties of Soil according to the variations in the substrata illustrated by the most descriptive names. Scale 5 miles to one inch.
- Geological Table of British Organised Fossils which identify the courses and continuity of the Strata in their order of superposition as originally discovered by W. Smith, Civil Engineer, with reference to his Geological Map of England and Wales.
- A Memoir to the Map and Delineation of the Strata of England and Wales with part of Scotland. [General account of Yorkshire, pp. 33-35.] 4to. *London*.
1816. ANON [N. J. WINCH]. Answer to the Geological Queries of a Constant Reader (in previous no., p. 12). [Refers to coal worked at Easingwold.] *Phil. Mag.*, vol. xlvii., pp. 100, 101.
1817. ANON. Answers to the Geological Queries by N. J. Winch, Esq., with some Remarks, and further Queries proposed to that Gentleman, and other practical Investigators of the Strata of the North of England. [Coal and Lias limestone at Thirkelby.] *Phil. Mag.*, vol. xlix., pp. 250-256.
- ANON. The Tourist's Companion: being a Concise Description and History of Ripon, Studley Park, Fountains Abbey, Hackfall, Brimham Crags, Boroughbridge, Aldborough, Newby Hall, Knaresborough, Plumpton, Harrogate, and Harewood House. [Harrogate. Analyses of waters, pp. 93-97; Devil's Arrows, pp. 59-62.] 16mo. *Ripon*. Ed. 3, 1822; Ed. 5, 1828; Ed. 6, 1833. Copyright purchased in 1841, and re-issued under new title. See Anon [J. R. Walbran], 1841.
- MURRAY, Dr. [Sulphate of Strontia in the banks of the Nidd, near Knaresborough.] *Trans. Geol. Soc.*, vol. iv., p. 445.
1819. HUNTER, Dr. ADAM. An Essay on Two Mineral Springs recently discovered at Harrogate; and on the Springs of Thorpe-arch and Ilkley; including the history, chemical analysis, and medicinal properties of these waters, with some observations on their use. Pp. iv., 134. 8vo. *Leeds and London*.
- MACKENZIE, Dr. P. Practical Observations on the Medical Powers of the most celebrated Mineral Waters, and of the various modes of Bathing. Pp. 151. 12mo. *London*.

1820. SCUDAMORE, Dr. C. A Chemical and Medical Report of the Properties of the Mineral Waters of Buxton, Matlock, Tunbridge Wells, Harrogate, Bath, Cheltenham, Leamington, Malvern, and the Isle of Wight. [Harrogate, p. 90-126.] Pp. 265. 8vo. London. Ed. 2. Under different title, Pp. xi., 215. 8vo. London. 1833.
- SMITH, W. A New Geological Map of England and Wales with the Inland Navigations; exhibiting the districts of Coal and other Sites of Mineral Tonnage. Scale about 12 miles to one inch. Another Ed., 1828. Scale 15 miles to one inch.
- WILLIAMS, J. W. An Essay on the Utility of Sea Bathing, In preserving Health, and as a Remedy in Disease . . . Also Observations on Mineral Waters, Natural and Artificial. [Harrogate, p. 221.] 12mo. Portsmouth.
1821. *MILLER, J. Practical Observations on Cold and Warm Bathing, and descriptive notices of Watering Places in Britain. 12mo. London.
- SMITH, W. Geological Map of Yorkshire. 4 sheets. Scale about $2\frac{3}{4}$ miles to one inch.
1822. ANON. Knaresborough Spaw. [Comparison of Dr. Murray's analysis of Knaresborough Spaw and Dr. Scudamore's analysis of the Sulphur Water of Low Harrogate.] 4to. Knaresborough.
- CONYBEARE, Rev. W. D., and W. PHILLIPS. Outlines of the Geology of England and Wales with an introductory compendium of the General Principles of that Science, and Comparative views of the Structure of Foreign Countries. [Harrogate springs alluded to, pp. 310 and 351.] 8vo. London.
- WINCH, N. J. On Blocks of Granite, Syenite, &c., imbedded on Diluvium. [Inquiry as to cause of these erratics.] *Ann. Phil.*, n. ser., vol. iii., p. 373.
1823. CALVERT, M. An Account of the Knaresborough Spaw; with an Analysis of the water, and some general observations on its medicinal qualities and effects. 16mo. Knaresborough. Ed. 2, Pp. 32, 1831. Ed. 3, Pp. 40, 1836.
- FAREY, J. On the unconformable Position of the Pontefract Rock of Sandstone, with respect to the subjacent Coal-measures, as shown in the new Geological Map of Yorkshire; and regarding some Errors therein as to parts of the Ranges of certain Rocks in the Coal Series. [Origin of Harrogate springs, p. 277.] *Ann. Phil.*, vol. v., pp. 270-278.
- WEST, W. Analysis of a New Sulphur Spring at Harrogate, *Quart. Journ. Sci. Lit. Art.*, vol. xv., pp. 82-89.
1824. ATKINSON, J. Sketch of the Geographical Distribution of Plants in Yorkshire [on the Magnesian Limestone between Knaresborough and Ripon]. *Mem. Wernerian Soc.*, vol. v., pt. 1, pp. 277-286, and *Phil. Mag.*, vol. lxiv., pp. 211-217.
1825. ANON. Strontites in Yorkshire. [Carbonate near Pateley Bridge, Sulphate near Knaresborough]. *Edin. Phil. Journ.*, vol. xii., p. 178.
- SEDGWICK, A. On the Origin of Alluvial and Diluvial Formations. *Ann. Phil.*, vol. ix., pp. 241-257; vol. x., pp. 18-37.
1826. MARSHALL, W. Notice on Carbonate of Copper occurring in the Magnesian Limestone, at Newton Kyme, near Tadcaster. [Also at Farnham.] *Trans. Geol. Soc.*, ser. 2, vol. ii., pp. 140-141.
1827. ANON. The Stranger's introduction to Harrogate; containing a variety of useful information, relating to the accommodation, the recreations and the different Mineral Waters of this celebrated watering place. [Table of analyses.] Ed. 4, Pp. 52, 12mo. Leeds.
- GEORGE, E. S. Analysis of a Sulphuretted Water from the Northern Part of the Yorkshire Coalfield. [Similarity of the water to some at Harrogate.] *Phil. Mag.*, ser. 2, vol. i., pp. 245-248.
- PHILLIPS, Prof. J. On the Direction of the Diluvial Currents in Yorkshire. *Phil. Mag.*, vol. ii., pp. 138-141.

1827. SEDGWICK, A. On some beds associated with the magnesian limestone, and on some fossil fish found in them. *Proc. Geol. Soc.*, vol. i., pp. 2, 3.
1828. INCHBOLD, T. Harrogate and its Environs, illustrated by a series of lithographic views. [History of the springs.] Pp. 79, 8vo. *Leeds*.
 PHILLIPS, J. Geological Observations made in the Neighbourhood of Ferrybridge, in the years 1826-1828. [Sandstone pebbles in the Drift similar to the rock at Harrogate and Ripley, p. 405.] *Phil. Mag.*, ser. 2, vol. iv., pp. 401-409.
- 1828-1831. ALLEN, T. A New and Complete History of the County of York. [Soil, vol. i., pp. 131-135; Mineralogy, Geology, &c., pp. 160-170; Harrogate, vol. iii., pp. 404-407; Boroughbridge, pp. 409-410; Knaresborough, p. 401.] 3 vols. 4to. *London*. 1828-1831.
1829. ANON [L.E.O.]. Granite found north of the Humber. [Found in sinking a well near Woodend, about eight miles from the Hambleton Hill at a depth of 60 or 70 yards]. *Mag. Nat. Hist.*, vol. i., pp. 396, 397.
 ANON [W.C.T.]. The Granite in Yorkshire. [States that the above is a boulder.] *Ibid.*, vol. ii., p. 120.
- OSANN, E. Physikalisch—medizinische Darstellung der bekannten Heilquellen der vorzüglichsten Länder Europa's. [Harrogate Eisenwasser, vol. i., p. 349; Schwefelwasser, p. 350.] 2 vols. 8vo. *Berlin*. Ed. 2. 3 vols. 8vo. *Berlin*. 1839-1843.
- PHILLIPS, Prof. J. Illustrations of the Geology of Yorkshire; or a Description of the Strata and Organic Remains; accompanied by a Geological Map, Sections, and Plates of the Fossil Plants and Animals. Part I. The Yorkshire Coast. [Central Yorkshire, 3rd Ed., pp. 1-23.] 4to. *York*. Ed. 2. 4to. *London*. 1835. Ed. 3. By R. ETHERIDGE. 4to. *London*. 1875.
- SEDGWICK, Rev. Prof. A. On the Geological Relations and internal Structure of the Magnesian Limestone, and the lower Portions of the New Red Sandstone Series in their Range through Nottinghamshire, Derbyshire, Yorkshire and Durham to the Southern Extremity of Northumberland. *Trans. Geol. Soc.*, ser. 2, vol. iii., pp. 37-124, 239. *Phil. Mag.*, ser. 2, vol. i., pp. 229-231 (1827). [Long abstract in *Proc. Geol. Soc.*, vol. i., pp. 63-66 (1827).]
- SOWERBY, J. and J. DE C. The Mineral Conchology of Great Britain. Vol. vi. (Producta calva, from the Magnesian Limestones near Tanfield, p. 116). 8vo. *London*.
1830. BOOTH, A. A Treatise on the Natural and Chymical Properties of Water, and on various British Mineral Waters. Pp. 196, 12mo. *London*. Another Ed., Pp. xii., 196, 12mo. *London*, 1838.
- DAUBENY, Prof. C. Réflexions Chimico-Géologiques sur les Eaux Minérales et leur origine, suggérées par la Lecture de deux ouvrages, celui de M. Scudamore, sur les Eaux de Buxton, Matlock, etc., et celui de M. Le D. G. Bishof, sur les sources volcaniques, etc. [Discusses Scudamore's work on Harrogate Waters.] *Journ. Geol.*, t. ii., pp. 113-136.
- DE LA BECHE, Sir H. T. Sections and Views illustrative of Geological Phenomena. [General vertical section of Yorkshire Strata.] 4to. *London*.
- HUNTER, Dr. ADAM. A Treatise on the Mineral Waters of Harrogate and its Vicinity. Pp. vii., 138, 12mo. *London*. Ed. 3, Pp. vii., 138, 1833. Ed. 4, 1834. Ed. 5, Pp. ix., 196, 1838. Another Ed., 1846.
- HUNTER, Rev. J. The Diary of Ralph Thoresby, Author of the topography of Leeds (1677-1724), now first published from the original manuscript. [Devil's Arrows at Boroughbridge, vol. i., p. 432.] 2 vols., 8vo. *London*.

1831. ANON (T. E. L.) A Sketch of the Flora of Richmond, Yorkshire, as compared with that of Thirsk, in the same County. [Marl and Lias of the Vale of York.] *Mag. Nat. Hist.*, vol. iv., pp. 24-28, 276. 467.
- PHILLIPS, Prof. J. On some effects of the atmosphere in wasting the surfaces of buildings and rocks. [Brimham Crags and Devil's Arrows.] *Proc. Geol. Soc.*, vol. i., pp. 323, 324.
- . An extemporaneous account of the most remarkable phenomenon in the Geology of Yorkshire. *Rep. Brit. Assoc. for 1830*, p. 56.
- WEST, W. Practical and Philosophical Observations on Natural Waters. [Carburetted hydrogen in the Harrogate Sulphur Water, p. 45.] *Journ. Roy. Inst.*, n.s., vol. i., pp. 38-46.
1832. FITTON, Dr. W. H. Notes on the History of English Geology. *Lond. Edin. Phil. Mag.*, vol. i., pp. 147-160, 268-275, 275-450 ; vol. ii., pp. 37-57.
- GAIRDNER, Dr. M. Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs. [Harrogate and Knaresborough, pp. 149, 217, 233.] 12mo. *Edinburgh and London*.
1833. PHILLIPS, Prof. J. [Lecture on the Geology of Yorkshire. Alludes to the character of the Carboniferous Rocks and to Borough-bridge.] *Trans. Brit. Assoc. for 1831*, pp. 56-58.
1834. CONYBEARE, W. D. On the probable future Extension of the Coal-fields at present worked. [Coal worked on the banks of the Nid, near Bilton, p. 162.] *Phil. Mag.*, ser. iii., vol. iv., pp. 161-163.
- LEE, EDWIN. An Account of the most frequented Watering Places on the Continent, and of the medical application of their mineral springs ; with Tables of Analysis ; and an Appendix of English Mineral Waters. [Harrogate. Ed. 2, pp. 216-221.] 8vo. *London*. Ed. 2, Pp. 232, 1836. 8vo. *London*.
1836. PHILLIPS, Prof. J. Illustrations of the Geology of Yorkshire ; or a Description of the Strata and Organic Remains ; accompanied by a Geological Map, Sections and Diagrams, and Figures of the Fossils. Part II. The Mountain Limestone District. 4to. *London*.
1837. ANON. The Tourist's Guide ; being a concise history and description of Ripon, Studley Royal, Fountains Abbey, Markenfield, Brimham Rocks, Hackfall, and Newby Hall ; intended as a companion to persons visiting those places. . . . [Brimham Rocks, pp. 99-101.] Pp. 106. 8vo. *Ripon*. Ed. 2, 1838.
- DAUBENY, C. Report on the Present State of our Knowledge with respect to Mineral and Thermal Waters. *Rep. Brit. Assoc. for 1836*, pp. 1-95. *L'Institut.*, t. vi., pp. 219, 220, 235, 236, 271, 272 [1838] ; t. vii., pp. 4-8, 14-16, 36-40, 46-48, 55, 56, 62-64, 91, 92 [1839].
- PHILLIPS, Prof. J. On the Removal of large Blocks or Boulders from the Cumbrian Mountains in various directions. [Vale of York.] *Rep. Brit. Assoc. for 1836*. Sections p. 87.
- REPORT. A Report of the trial The King v. Thackwray respecting the sulphur wells at Low Harrogate with notes, &c. Tried at York Assizes before Baron Alderson and a Special Jury, March 14th, 1837. 8vo. *Harrogate*.
- TÖÖKE, A. W. The Mineral Topography of Great Britain. [Celestine at Knaresborough, Sulphate of Strontian in the Nidd, p. 54.] *Mining Review*. No. ix., pp. 39-60. No. x., pp. 197-209.
1838. ANON. An Historical and Descriptive Account of Brimham Rocks, in the West Riding of Yorkshire. Pp. 23. 2 woodcuts. 8vo. *Ripon*. Ed. 3, Pp. 14. 12mo. *Ripon*. Ed. 4 12mo, 1842. Ed. 5, 1845. 12mo. *Ripon*.

1839. ANON. The History of Ripon with Historic Notices and Descriptions of Fountains Abbey, Studley, Swinton Park, Newby Hall, Brimham Crags, Plumpton, Knaresborough, Bolton Abbey, Harewood House, Harrogate, &c., &c., forming a compendious Guide for Visitors. Pp. 176. 12mo. *Ripon*. Reprinted in 1840 as the Harrogate Visitor's Handbook.
- WEATHERHEAD, W. The History of Netherdale from the times of the Ancient Britons to the Present Time, giving an account of the Most Remarkable Things, as the Lead Mines and other Minerals, . . . Brimham Rocks, &c. Pp. 56, 12mo. *Leeds*.
1840. ANON. The Harrogate Visitor's Hand-Book, containing descriptions of Ripon, Fountains Abbey, Studley, Hackfall, Swinton Park, Newby Hall, Brimham Crags, Plumpton, Knaresborough, Bolton Abbey, Harewood House, Harrogate, &c., to which is appended Observations on the Harrogate Waters, and Directions for their use, by ALFRED SMITH. 12mo. *Ripon*. Ed. 8, Pp. 92, 1847. Ed. 11, 1852. This is a reprint of the guide book published in 1839, which was founded on the History of Ripon, 1839.
- PALLISER, P. History and Directory of Harrogate, containing a variety of useful information ; to which is added a descriptive sketch of Knaresborough, &c. [History and analyses of Water.] Ed. 2, 8vo. *Harrogate*.
- PHILLIPS, Prof. J. On the Physical Geography of Yorkshire. [Introduction to The Flora of Yorkshire by H. BAINES. Pp. xvi., and geological map.] 8vo. *London*.
- SMITH, C. H. Lithology ; or Observations on Stone used for Building. Part I. Treating chiefly of the Sandstones. Pp. 40. 1840. Part II. Treating chiefly of the Magnesian Limestones of Yorkshire, Derbyshire and Nottinghamshire with reference to the selection of stone for building the exterior of the New Houses of Parliament. Pp. 36. 1844. 4to. *London*. Part I. also *Trans. Roy. Inst. British Arch.* vol. i., pt. i., pp. 129-168, 1842.
- THORPE, W. On the Geology [should be "Agriculture"] of the West Riding of Yorkshire, considered geologically—and first, of the New Red Sandstone district [Classification of soils, chiefly south of the Aire]. *Proc. Yorksh. Geol. Soc.* vol. i. [No. 3], pp. 46-86.
1841. ANON [J. R. WALBRAN]. The Harrogate Visitor's Pictorial Pocket Guide, to Ripley, Studley, Fountains Abbey, Newby Hall, Hackfield, Swinton, Markenfield Hall, Ripley, Harrogate, Knaresborough, Brimham Rocks, Bolton Priory, Harewood House, &c. [A Treatise on the Natural Uses and Effects of the Harrogate Mineral Waters (Analyses), pp. 69-79 ; Brimham Rocks, pp. 80, 81 ; Knaresborough, p. 82.] Pp. 93, 12mo. *Ripon*. See ANON., 1817.
- GRANVILLE, A. B. The Spas of England and principal sea-bathing places. Vol. i., Northern Spas. [Harrogate, pp. 36-38 ; Knaresborough and Aldfield, &c., pp. 87-127 ; also tables of analyses.] 3 vols., 8vo. *London*.
- LEE, EDWIN. The Mineral Springs of England, and their curative efficiency ; with remarks on Bathing, and on artificial mineral waters. [Harrogate, pp. 47-58.] Pp. 124, 12mo. *London*. Ed. ii., Pp. 212, 1848. Ed. iii., Pp. 280, 1854. Ed. iv., 1859. Ed. 1863.
- THORPE, Rev. W. On the Agriculture of the West Riding of Yorkshire, considered geologically : 2nd. On the Magnesian Limestone District. *Proc. Yorkshire Geol. Soc.*, vol. i., pp. 91-138.
1842. BENNETT, W. Observations on the Mineral Springs of Harrogate. [Position of springs and amount of salts.] Pp. 11, 8vo. *Harrogate*.

1842. CLAY, J. T. Observations on the Yorkshire Drift and Gravel. [Vale of York and Teesdale.] *Proc. Yorkshire Geol. Soc.*, vol. i., pp. 338-352.
- SMITH, ALFRED. The Harrogate Medical Guide. A Popular Treatise on the Mineral Waters of Harrogate, and the Diseases in which they are useful; with supplementary remarks on diet and exercise. [Analyses.] Pp. xi., 96. 8vo. *Ripon*. Ed. ii., 12mo. *London*, 1847. Ed. iii., Pp. xi., 116. 16mo. *London*, 1860.
1843. ANON. Yorkshire (Geology). [Red Marls and Magnesian Limestone of Ripon and Knaresborough.] *Penny Cyclopædia*, vol. xxvii., p. 671. Fol. *London*.
- BENNETT, Dr. W. Observations on the Sulphureous Springs of Harrogate. Pp. 64. 8vo. *London*.
- JOHNSON, Dr. J. Excursions to the Principal Mineral Waters of England in pursuit of Health and Information. [Harrogate, pp. 5-30.] 8vo. *London*.
- THORPE, W. On the Indications which are Guides in judging of the Fertility or Barrenness of the Soil. [Green Hamerton, p. 148]. *Proc. Yorksh. Geol. Soc.*, vol. ii., pp. 136 to 155. Vol. ii. is dated 1849.
1844. CALVERT, M. The History of Knaresborough: comprising an accurate and detailed account of the Castle, the Forest, and the several townships included in the said parish. [Knaresborough Spaws, pp. 95-105.] 12mo. *Knaresborough*.
- SMITH, C. H. See 1840.
- SPENCE, J. Analyses of Grasses, Soils, &c. [Table iv., Analyses of Magnesian Limestone from Knaresborough, South Stainley, Ripon, &c.] *Trans. York. Agric. Soc.*, No. 7, pp. 73-101.
- WALBRAN, J. R. The Pictorial Pocket Guide to Ripon and Harrogate; with topographical observations on Studley Royal, Brimham Rocks, Hackfall, and the Monastic Remains of Fountains and Bolton. [Brimham Rocks, pp. 84, 85. Harrogate, pp. 89-100.] 12mo. *Ripon*. Ed. 2, 12mo., 1847. Ed. 5, 8vo., 1851. Ed. 6, Pp. 137, 8vo., 1856. (A reprint called Ed. 6, 8vo., 1857.) Ed. 9, Revised by W. F. STEVENSON, 8vo., 1871. An Abridgment entitled 'A Guide to Ripon and Fountains Abbey.' Pp. 48, 8vo. *Ripon*, 1862.
1845. ANON. [W. LANGDALE]. A Guide to Harrogate with a correct account of the places in the neighbourhood, and a variety of information useful to visitors, with a map and engravings. [Harrogate, pp. 1-25; Knaresborough, 26-34; Plumpton, 34, 35.] Pp. 98. 12mo. *Harrogate and Knaresborough* [1845]. Another Ed., 1850.
- KENNION, G. On the Medicinal Springs of Harrogate. *Provincial Med. Surg. Journ.*, vol. ii., No. 35, pp. 540-543. Also Pp. 8. 12mo. *Harrogate*.
- LUCAS, W. On the Limestones of Yorkshire. [Analyses.] *Rep. Brit. Assoc.* for 1844. Sections, pp. 30, 31.
- WEST, W. On Mineral Springs and other Waters of Yorkshire. [Analyses of Harrogate Waters.] *Ibid.* Sections, pp. 105-112.
1846. ANON. The Stranger's Guide; being a concise history and description of Boroughbridge, The Devil's Arrows, and the Roman Antiquities at Aldborough. [The Devil's Arrows, pp. 12-19.] 12mo. *Boroughbridge*.
- BRIGGS, H. On Lime and its Uses in Agriculture. [Analyses of Magnesian Limestone.] *Proc. Yorksh. Geol. Soc.*, vol. ii, pp. 254-270.
1847. AKERMAN, J. Y. An Archaeological Index to Remains of Antiquity of the Celtic, Romano-British, and Anglo-Saxon Periods. [The Devil's Bolts at Boroughbridge, p. 18.] 8vo. *London*.

1848. CHARNOCK, J. H. On the Farming of the West Riding of Yorkshire. [Geological Map and account of soils.] *Journ. Roy. Agric. Soc.*, vol. ix., pp. 284-311, and *Trans. York. Agric. Soc.*, No. xi., p. 156.
- LEE, EDWIN. Baths and Watering Places of England, considered with reference to their curative efficacy with Observations on Mineral Waters, Bathing, &c. [Harrogate, pp. 37-49] Pp. 212, 8vo. *London*. This is the second edition of "The Mineral Springs of England," 1841. Ed. 3, Pp. 280, 1854.
- MILBURN, M. M. On the Farming of the North Riding of Yorkshire. [Small geological map and section. Analysis of limestone from Ripon.] *Journ. Roy. Agric. Soc.*, vol. ix., pp. 496-521; and *Trans. York. Agric. Soc.*, No. xi., p. 182.
1849. LEWIS, S. Topographical Dictionary of England. . . . [History of the Harrogate Wells.] 4to. *London*.
- THORPE, Rev. W. See 1843.
1852. SMITH, H. E. Reliquiæ Isurianæ: The Remains of Roman Isurium (now Aldborough, near Boroughbridge, Yorkshire), illustrated. [Devil's Arrows, pp. 7-9.] 4to. *London*.
1853. KENNION, Dr. G. Observations on the Medicinal Springs of Harrogate. (Extracted from the Medical Times and Gazette.) Ed. iv., Pp. 31., 8vo. *London*. Ed. v., Pp. 15, 1866. Ed. vi., 1869. Ed. vii., enlarged and revised by A. BEALEY, 8vo. *London*, 1870. This forms an appendix to the Illustrated Handbook for Harrogate, 1858.
- PHILLIPS, Prof. J. The Rivers, Mountains and Sea-coast of Yorkshire. [Devil's Arrows, pp. 65-67, 101; Harrogate, p. 71.] 8vo. *London*. Ed. 2, 1855.
- A Map of the Principal Features of the Geology of Yorkshire. (Scale 5 miles to an inch.) *York.*, Ed. 2, 1862.
- Excursion in Yorkshire by the North Eastern Railway. Pp. 88. 12mo. *York*. Ed. 2, 1854. Ed. 3, 1855.
- On some of the Relations of Archaeology to Physical Geography in the North of England. *Arch. Journ.*, vol. x. (No. 39, Sept., 1853), pp. 179-186. Reprinted 1854.
- PIGGOTT, Dr. G. W. (G. W. ROYSTON PIGOTT). On the Harrogate Spas: A handbook to the Nature and Uses of the Waters, with a brief commentary on the Medical action of the saline combinations exhibited in Professor Hofmann's analytical report. Ed. 1 and 2, 8vo., *London*, 1853; Ed. 3, Pp. 77, 8vo., 1855; New and enlarged Ed., Pp. 280, 12mo., *London*, 1856; Ed. 4, 8vo., 1865.
- THORPE, Rev. W. On the Diluvial and Gravel Beds of Yorkshire and Nottinghamshire. *Proc. Yorksh. Geol. Soc.*, vol. iii., pp. 244-252. [Vol. iii is dated 1859.]
1854. ANON. The Visitor's Guide to Ripon, Harrogate and adjoining country, including Fountains Abbey, Brimham, Bolton, Hackfall, Knaresborough and other places of interest: with appendix containing Hofmann's analysis. 8vo. *Ripon*, Pp. 113. Another Ed., 1856, Pp. 120. Another Ed., 1858.
- HOFMANN, A. W. Harrogate and its Resources. Chemical Analysis of its Medicinal Waters, with an Appendix on the mode of their Administration by the Committee. [Report to the Harrogate Water Committee.] Pp. 54, 8vo. *London*.
- HOFMANN, A. W. Synopsis of the Analyses of the Mineral Springs of Harrogate, extracted from Dr. Hofmann's Report, with practical remarks, by the Medical Section of the Water Committee. Pp. 16, 8vo. *London*.
- MURCHISON, Sir R. I. Siluria. The History of the Oldest known Rocks containing Organic Remains. With a brief sketch of the Distribution of Gold over the Earth. [Permian rocks, p. 303; Ed. 3. p. 348; Ed. 4, p. 329.] 8vo. *London*. Ed. 3, 1859. Ed. 4, 1867.

1854. PHILLIPS, Prof. J. On Magnetic Phenomena in Yorkshire. [Vale of York.] *Rep. Brit. Assoc. for 1853*, Sections, p. 6.
 ————On the Dispersion of Erratic Blocks at higher Levels than their Parent Rock in Yorkshire. *Ibid.*, p. 54.
- PIGGOTT, G. W. The Harrogate Spas: The Chloridal Steel Waters or Saline Chalybeates. Ed. 2. Pp. 36, 8vo. *London*.
1855. HOFMANN, A. W. Chemical Analysis of the Mineral Waters of Harrogate. [Report to the Harrogate Water Committee.] *Journ. Chem. Soc.*, vol. vii., pp. 161-179; *Pharm. Journ.*, vol. xiv., No. ii. pp. 74-77, No. iii. pp. 118-125; *Erdm. Journ. Prakt. Chem.*, bd. lxiv., pp. 221-225; *Liebig. Annal. Chem. Pharm.*, bd. xciii., pp. 286-310.
- SHEAHAN, J. J., and T. WHELLAN. History and Topography of the City of York; The Ainsty Wapentake; and the East Riding of Yorkshire. [Extracts from a newspaper account of a lecture by J. PHILLIPS given at Hull in 1853 entitled "Some Peculiar Phenomena in the Geology and Physical Geography of Yorkshire," pp. 20-27. Harrogate Springs, p. 35.] 2 vols., 8vo. *Beverley*. Vol. iii., by J. J. SHEAHAN, 1871.
1857. DURAND-FARDEL, M. Traité thérapeutique des eaux minérales de France et de l'Etranger, et de leur emploi dans les maladies chroniques. [Harrogate, p. 113.] 8vo. *Paris*. Ed. 2, Pp. 773. 8vo. *Paris*, 1862. Ed. 3, 1883.
- GLOVER, R. M. On Mineral Waters: their Physical and Medicinal Properties with descriptions of the different mineral waters of Great Britain and the Continent, and directions for their administration. [Harrogate, pp. 72-91.] Pp. 375. 8vo. *London and Edinburgh*.
1858. ANON. The Illustrated Hand-Book for Harrogate, with excursions in the neighbourhood. [Observations on the medicinal springs of Harrogate by Dr. G. KENNION, p. 93.] Pp. 168, 12mo. *Harrogate*. A later edition, 1872, published by T. HOLLINS, as Hollins' Handbook for Harrogate.
1859. GRAINGE, W. The Vale of Mowbray: A Historical and Topographical Account of Thirsk and its neighbourhood. [Geological Map.] 8vo. *London*.
- SORBY, H. C. On the Currents present during the Deposition of the Carboniferous and Permian Strata in South Yorkshire and North Derbyshire. *Rep. Brit. Assoc. for 1858*, Sections, p. 108.
 ————On the Structure and Origin of the Millstone-Grit in South Yorkshire. *Proc. Yorksh. Geol. Soc.*, vol. iii., pp. 669-675.
1860. DURAND FARDEL, M. Dictionnaire Général des Eaux Minérales et d'Hydrologie Médicales. . . . [Harrogate, vol. ii., pp. 85-87, and analyses]. 2 vols. 8vo. *Paris*.
1861. GRAINGE, W. A Guide to Harrogate and Visitor's Hand-book of the town and neighbourhood. [Geological notes, pp. 1-4.] Pp. iv., 86, 16mo. *Harrogate*. Another Ed., Pp. 80, 8vo. *Pateley Bridge*, 1875.
- KIRKBY, J. W. On the Permian Rocks of South Yorkshire, and on their Palaeontological Relations. [South Yorkshire compared with Durham.] *Quart. Journ. Geol. Soc.*, vol. xvii., pp. 287-325.
- REPORT. Harrogate Improvement Commissioners: Supply and Conservation of the Sulphur Waters of Harrogate. Special meetings Dec. 30th, 1861. Printed for private circulation. Pp. 38, 4to. *Harrogate*.
1862. ALTHAUS, J. The Spas of Europe. [Harrogate analyses, pp. 473, 474.] 8vo. *London*.
- GRAINGE, W. Memoir of the life of Sir William Slingsby discoverer of the first spaw at Harrogate. Pp. 21. 12 mo. *Harrogate*.
- HULL, E. On Iso-diametric Lines, as means of representing the Distribution of Sedimentary Clay and Sandy Strata, as distinguished from Calcareous Strata with special reference to the Carboniferous Rocks of Britain. *Quart. Journ. Geol. Soc.*, vol. xviii., pp. 127-146.

1863. BAKER, J. G. North Yorkshire ; studies of its Botany, Geology, Climate, and Physical Geography. [Geology revised by Prof. J. PHILLIPS, pp. 5-34.] Geological Map. 8vo. *London*. Ed. 2, 8vo. *Leeds*, 1889.
- GRAINGE, W. Nidderdale ; or an Historical, Topographical, and Descriptive Sketch of the Valley of the Nidd. [Alludes to geology about Ripley.] 8vo. *Pateley Bridge*.
1864. GRAINGE, W. The Geology of Harrogate ; to which are appended statements and opinions never before published of Dr. William Smith ; Professors Phillips, Daniel and Turner ; William West of Leeds ; Thomas Sopwith, C.E. ; Professor Johnstone of Durham, John Buddle, C.E. ; and others ; on the origin of the Medicinal Waters of Harrogate. 12mo. *Harrogate*.
- MUSPRATT, Dr. S. Analysis of the Harlow Car Waters, near Harrogate. *Chem. News*, vol. ix, pp. 180, 181.
- ROTUREAU, A. Des principales eaux minérales de L'Europe. [Harrogate, pp. 92-105]. 3 vols. not numbered, 8vo. *Paris*. Earlier editions, *Germany* and *Hungary*, 1858 ; *France*, 1859.
1865. ANON. [T. RUPERT JONES, Letter on.] A new Coalfield in Yorkshire. [Nevison's Farm, near Thirsk.] *Geol. Mag.*, vol. ii., p. 140.
- GRAINGE, W. The Tourist's Guide to Brimham Rocks in the township of Hartwith, and West-Riding of Yorkshire. (Extracted from Nidderdale.) Ed. 2. Pp. 16. 12mo. *Pateley Bridge*.
- MACKINTOSH, D. Marine Denudation illustrated by the Brimham Rocks. *Geol. Mag.*, vol. ii, pp. 154-158.
- MUSPRATT, Dr. J. S. Analysis of the Montpellier Saline Chalybeate, Water. *Chem. News*, vol. xii, p. 37.
- The Cheltenham Saline Chalybeate Water, Harrogate. *Ibid.* pp. 83, 215.
- PHILLIPS, Prof. J. Note on the Geology of Harrogate. *Quart. Journ. Geol. Soc.*, vol. xxi., pp. 232-235.
1866. BINNEY, E. W. A few Remarks on the so-called Lower New Red Sandstones of Central Yorkshire. [That they are of Millstone Grit age.] *Geol. Mag.*, vol. iii., pp. 49-55.
- The so-called Lower New Red Sandstone of Plumpton, Yorkshire [Letter pointing out its Millstone Grit age.] *Ibid.*, pp. 473, 474.
- C[HURCH], A. H. Ferrous Chloride in a Mineral Water. [Cheltenham Saline Chalybeate Well at Harrogate.] *Geol. Mag.*, vol. iii. p. 285.
- DAVIS, R. H. Note on the Existence of Lithium, Barium, and Strontium in the Medicinal Springs of Harrogate.] *Chem. News*, vol. xiii., pp. 302, 303.
- The Imperial Saline Ferruginous Well at Harrogate (formerly called the Cheltenham Saline Chalybeate Well), its History and Analyses. *Pharm. Journ.*, ser. 2, vol. vii., pp. 458-463.
- GREENOUGH, G. B. A Geological Map of England and Wales (on the basis of the original Map of Wm. Smith, 1815), revised and improved under the superintendence of a Committee of the Geological Society of London, from the Maps of the Geological Survey of Great Britain 1836-1863 and Maps and Documents contributed by Sir R. I. Murchison, Professor Phillips, Joseph Prestwich, R. Godwin Austen and others. Scale, $5\frac{1}{2}$ miles to an inch.
- MACKINTOSH, D. The Relative Extent of Atmospheric and Oceanic Denudation, with a particular reference to certain Rocks and Valleys in Yorkshire and Derbyshire. [Marine denudation of Brimham Rocks.] *Rep. Brit. Assoc.*, for 1865. Sections, pp. 65, 66.

1866. MUSPRATT, DR. J. S. Discovery of a new Chalybeate at Harrogate. *Chem. News.*, vol. xiii., pp. 26, 27.
 ——"Dr. Muspratt's Chalybeates," in Harrogate. *Ibid.*, pp. 203, 204, 224, 238, 299.
 ———New Analysis of the Montpellier Saline Chalybeate (Kissingen) Water at Harrogate. *Ibid.*, vol. xiv., p. 49.
- THORPE, J. Ripley, its History and Antiquities. [Quotation from PROF. PHILLIPS, p. 111.] Pp. 164. 8vo. *Harrogate.*
- TUTE, [Rev.] J. S. The Lower New Red Sandstone of Central Yorkshire. *Geol. Mag.*, vol. iii., pp. 185-189.
1867. BLACK, A. and C. Black's Guide to Yorkshire. [Analyses and History of the Harrogate Wells, pp. 134-141.] Ed. 4, 12mo. *Edinburgh.*
- CURRY, J. On the Drift of the North of England. *Quart. Journ. Geol. Soc.*, vol. xxiii., pp. 40-44.
- MURCHISON, Sir R. I. On the Parts of England and Wales in which Coal may and may not be looked for beyond the known Coal-fields. [Harrogate, p. 61.] *Rep. Brit. Assoc. for 1866.* Sections, pp. 57-63.
- MUSPRATT, DR. J. S. Recent Analysis of the Montpellier Saline Chalybeate (Kissingen) Spring at Harrogate. *Chem. News*, vol. xv., pp. 244, 245.
- MYRTLE, DR. A. S. Practical Observations on the Harrogate Mineral Waters, with Cases Illustrative of their Action. *Glasgow Med. Journ.*, vol. i., pp. 409-425. Discussion, pp. 489-494. Afterwards published in book form and went through many editions. Pp. 98. 8vo. *London*, 1867. Ed. 2, 1869. Ed. 3, 1874. Ed. 4, *Harrogate*, 1893.
1868. HULL, E. Observations on the Relative Ages of the Leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire. *Quart. Journ. Geol. Soc.*, vol. xxiv., pp. 323-335.
- MUSPRATT, DR. J. S. Recent Analysis of the Water of the 'Old Sulphur Well,' Royal Pump Room, Harrogate. *Chem. News*, vol. xviii., pp. 155, 156.
 ———Recent Analysis of the 'Hospital Mild Sulphur Spring,' or 'Magnesia Water,' Royal Pump Room, Harrogate. *Ibid.*, p. 195.
- TUTE, Rev. J. S. The Geology of the Country near Ripon. *Proc. Yorkshire Geol. Soc. for 1867*, vol. iv., pp. 555-565.
 ———On certain Natural Pits in the Neighbourhood of Ripon. *Geol. Mag.*, vol. v., p. 178. *Proc. Yorkshire Geol. Soc. for 1869*, vol. v., pp. 2-7. 1870.
1869. AVELINE, W. T., J. R. DAKYNS, and C. FOX-STRANGWAYS. Sheet 172 (Wetherby, Cowthorpe) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- MACPHERSON, J. The Baths and Wells of Europe;
 [Harrogate, pp. 230-232.] 8vo. *London.*
- MANSON, D. On the Sulphur Waters of Strathpeffer in the Highlands of Ross-shire with district guide. [Compared with Harrogate waters, pp. 5, 6, 7, 8, 38.] Pp. 78, 8vo. *London.* Ed. 2, 1877; Ed. 3, 1879; Ed. 4, 1881; Ed. 5, 1884.
- MUSPRATT, DR. J. S. Analysis of the Water of the Royal Sulphur Spring, Harrogate. *Chem. News*, vol. xx., pp. 26, 68.
- STRANGWAYS, C. FOX-. Sheet 155 (Goldsborough, Allerton) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- WARD, J. C. On Beds of supposed Rothliegende Age, near Knaresborough. *Quart. Journ. Geol. Soc.*, vol. xxv., pp. 291-297.
1870. AVELINE, W. T., J. C. DAKYNS, J. C. WARD, and R. RUSSELL. Sheet 93, S.W., of the Map of the Geological Survey of England.

1870. AVELINE W. T., A. H. GREEN, J. R. DAKYNS, J. C. WARD, and R. RUSSELL. The Geology of the Carboniferous Rocks North and East of Leeds, and the Permian and Triassic Rocks about Tadcaster. (Explanation of Quarter-sheet 93, S.W.) *Geological Survey Memoir*. 8vo. London.
- AVELINE, W. T., J. C. WARD, and J. LUCAS. Sheet 188 (Harewood) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- AVELINE, W. T., J. R. DAKYNS, J. C. WARD, and J. LUCAS. Sheet 189 (Wetherby). Ditto.
- DAKYNS, J. R. Sheet 190 (Tadcaster). Ditto.
- LUCAS, J. Sheet 170 (Fewston). Ditto.
- LUCAS, J., and C. FOX-STRANGWAYS. Sheet 153 (Hampsthwaite) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- MYRTLE, A. S. Hydrotherapeutics; the resources of Harrogate specially considered. [Notes and analyses of the waters.] Pp. 26, 8vo. *Harrogate*.
- SABINE, SIR E. Contributions to Terrestrial Magnetism. No. xii. Magnetic Survey of the British Islands, reduced to the Epoch, 1842-5. *Phil. Trans.*, vol. 160, pp. 265-275.
- SUGDEN, S. Analyses of the Mineral Waters in the Montpellier Grounds Low Harrogate, with the diseases in which they are used. . . . 16mo. *Harrogate*.
- TUTE, Rev. J. S. See 1868.
- WOOD, S. V., jun. On the Relation of the Boulder-clay, without Chalk, of the North of England to the Great Chalky Boulder-Clay of the South. *Quart. Journ. Geol. Soc.*, vol. xxvi., pp. 90-111.
1871. BAINES, T. Yorkshire past and present: A History and a Description of The Three Ridings of the Great County of York, from the earliest ages to the year 1870; with an Account of its manufactures, Commerce, and Civil and Mechanical Engineering. [Geology and Agriculture, pp. 9-106; Harrogate, vol. ii., p. 610]. 2 vols. issued in parts, 1871-1877. 4to. London.
- DAKYNS, J. R., and C. FOX-STRANGWAYS. Sheet 156 (Newton on Ouse, Kirk Hammerton, Shipton) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- GRAINGE, W. The History and Topography of Harrogate, and the Forest of Knaresborough. [Geology, pp. 22-30; Harrogate Waters, pp. 127-147.] 8vo. *Pateley Bridge* and London. Another Ed., Pp. xii., 511, 1882.
- LUCAS, J., and C. FOX-STRANGWAYS. Sheet 136 (Sawley, Brimham Rocks) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office. [1871 ?]
- MACKINTOSH, D. On the Nature, Correlation, and Mode of Accumulation of the Drift-Deposits of the West Riding of Yorkshire; with Remarks on the Origin of Escarpments, Valleys, and Outlets-gorges, and an Appendix on the Cliffs of Plumpton, Brimham, Goredale and Malham. *Proc. Yorksh. Geol. Soc.* for 1870, vol. v., pp. 130-134; *Geol. Mag.*, vol. vii., pp. 284-286, 1870.
- MACPHERSON, Dr. J. Our Baths and Wells: The Mineral Waters of the British Islands, with a list of Sea Bathing Places. [Harrogate, pp. 126-138.] Pp. 205. 8vo. London and New York.
- SHEAHAN, J. J. History and Topography of the Wapentake of Claro, being a supplementary volume to T. Whellan and Co.'s History of York and the North Riding. [Harrogate, pp. 137-151; Devil's Arrows, p. 186.] Vol. iii., 8vo. *Beverley*.
- STRANGWAYS, C. FOX-. Sheets 137 (Copgrove), 138 (Boroughbridge) and 139 (Alne), of the Geological Survey Map of Yorkshire (6 inches to a mile). MSS. in the Geological Survey Office.

1871. WARD, J. C., and C. FOX-STRANGWAYS. Sheet 154 (Harrogate, Knaresborough) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office.
- WOOD, S. V., jun. Mr. Croll's Hypothesis of the Formation of the Yorkshire Boulder-clay. *Geol. Mag.*, vol. viii., p. 92.
1872. DAKYNS, J. R., On the Glacial Phenomena of the Yorkshire Uplands [Gravels of the Vale of York.] *Quart. Journ. Geol. Soc.*, vol. xxviii., pp. 382-388.
- and C. FOX-STRANGWAYS. Sheet 174 (York) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey. Drift copy, 1882.
- GREEN, A. H. On the Method of Formation of the Permian Beds of South Yorkshire. *Geol. Mag.*, vol. ix., pp. 99-101.
- LUCAS, J. The Permian Beds of Yorkshire. *Ibid.*, pp. 338-343.
- RAMSAY, Prof. A. C. On the River-courses of England and Wales *Quart. Journ. Geol. Soc.*, vol. xxviii., pp. 148-160.
- STRANGWAYS, C. FOX-. Sheets 140 (Sutton on the Forest, Sheriff Hutton) and 157 (Strensall, Haxby, Huntingdon) of the Geological Survey Map of Yorkshire (6 inches to a mile). MSS. in the Geological Survey Office.
- WARD, J. C. On Rock-Staining. *Geol. Mag.*, vol. ix., pp. 389-391.
- WOOD, S. V., jun. Reply to Mr. James Geikie's Correlation of the Scotch and English Glacial Beds. [Vale of York.] *Ibid.*, pp. 171-176.
1873. DAVIS, R. H. Monthly Analytical Examinations of the Harrogate Spas, 1872. *Journ. Chem. Soc.*, New ser., vol. xi. Entire ser. vol. xxvi., pp. 1089-1092.
- MIALL, L. C. The Permian Rocks of the Neighbourhood of Leeds. *Leeds Nat. Field Club*, Aug. 5th, 1873; *Geol. Mag.*, vol. x., pp. 421, 422; *Nature*, vol. viii., p. 335.
- TUTE, Rev. J. S. A Probably New Species of *Orthoceras* (*Orthoceras pennatum*). [In Millstone Grit 7 miles S.W. of Ripon.] *Hardwicke's Science Gossip*, No. 103, pp. 154, 155, Figs. 87-97. An abstract of this in *Proc. Yorksh. Geol. Soc.*, vol. vii., pt. i., pp. 82, 83. 1879.
1874. ANON. Guide to Harrogate, Ripon, Knaresborough, Fountains Abbey, Studley Park, Hackfall, Plumpton, Harewood House, Brimham Rocks, Bolton Abbey, and all places of interest in the district. [Analyses of Harrogate Waters.] Pp. ii., 48. 12mo. *Newcastle-on-Tyne*.
- AVELINE, W. T., J. R. DAKYNS, and C. FOX-STRANGWAYS. Sheet 93, N.W., of the Map of the Geological Survey of England.
- DAVIS, R. H. Monthly analytical examination of the Harrogate Spa, 1872. *Pharm. Journ.*, vol. iv., pp. 481, 482.
- FAIRLEY, T. Analysis of Water taken from the Old Sulphur Well, Harrogate, Nov. 14, 1873. *Chem. News*, vol. xxx., No. 774, p. 151.
- GEIKIE, J. The Great Ice Age and its relation to the Antiquity of Man. 8vo. *London*. Ed. 2, 1877. Ed. 3, 1894.
- HOBKIRK, C. P. On the Mosses of the West Riding of Yorkshire. [Principal geological features of the district.] *Rep. Brit. Assoc.* for 1873, Sections pp. 104, 105. *Journ. Bot.*, n.s., vol. ii., p. 327.
- STRANGWAYS, C. FOX. The Geology of the Country North and East of Harrogate. (Explanation of Quarter-sheet 93, N.W.) *Geological Survey Memoir*. 8vo. *London*. Dated 1873, but not issued till 1874.
- 1875 BRAUN, J. On the Curative Effects of Baths and Waters, being a Handbook to the Spas of Europe. [Harrogate, pp. 217, 291, 464, 465, 466, 471]. An abridged translation with notes by H. WEBER. 8vo. *London*.

1875. DAKYNS, J. R., J. LUCAS, C. FOX-STRANGWAYS and W. H. DALTON. Sheet 102 of the Horizontal Sections of the *Geological Survey*. (Dated 1874, not published until 1875.) Section from Heptonstall Moors north of Todmorden, across the Millstone Grit of the basin of the Calder, the outliers of the Lower Coal Measures at Denholme and Baildon, the Millstone Grit of Otley Chevin and Wharfedale, and the Yoredale Rocks of the Harrogate Anticlinal, on to the Magnesian Limestone of Knaresborough.
- HIRSCHFELD, J., and W. PICKLER. Die Bader Quellen und Curorte Europa's. [Harrogate, vol. i., p. 409.] 2 vols. 8vo. *Stuttgart*.
- LEBOUR, G. A. On the Limits of the Yoredale Series in the North of England. *Geol. Mag.*, dec. ii., vol. ii., pp. 539-544. *Rep. Brit. Assoc.* for 1875, Sections, pp. 74, 75.
- PHILLIPS, Prof. J. Illustrations of the Geology of Yorkshire; or a Description of the Strata and Organic Remains. [Bibliography by W. WHITAKER.] Ed 3, by R. ETHERIDGE. 4to. *London*.
- [WARD, J. C., J. LUCAS, and C. FOX-STRANGWAYS]. Sheet 171 (Pannal, Spofforth, Plompton) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office. [1875].
1876. DE RANCE, C. E. First Report of the Committee. appointed for the purpose of investigating the Circulation of the Underground Waters in the Jurassic, New Red Sandstone and Permian Formations of England, and the Quality and Quantity of the Water supplied to Towns and Districts from these formations. [Average thickness of Permian and Trias; wells at York, Selby, Bilton Hall, &c., pp. 126, 127.] *Rep. Brit. Assoc.* for 1875, p. 118.
- GREEN, A. H., J. R. DAKYNS, J. C. WARD, C. FOX-STRANGWAYS, and R. RUSSELL. Sheet 100 of the Horizontal Sections of the *Geological Survey*. Section from the neighbourhood of Boroughbridge to the centre of the Yorkshire Coalfield, crossing the Triassic Rocks south of Boroughbridge, the Permian Rocks of Knaresborough, Wetherby, Tadcaster, and Aberford; the Lower Coal Measures of Farlington Hollins; the Middle Coal Measures of Garforth and Kippax; the Magnesian Limestone of Preston Hill; and the Middle Coal Measures of Great and Little Preston, Methley Whitwood, Sharlston, and Nostel.
- TATE, R., and J. F. BLAKE. The Yorkshire Lias. 8vo. *London*.
- THORPE, T. E. A Contribution to the History of the Old Sulphur Well, Harrogate. *Phil. Mag.*, ser. 5, vol. ii., pp. 50-58; *Journ. Chem. Soc.*, vol. i., (xxxi.), pp. 181, 182 (1877).
- WARD, J. C., J. LUCAS, C. FOX-STRANGWAYS, and R. RUSSELL. Sheet 99 of the Horizontal Sections of the *Geological Survey*. Section from the Magnesian Limestone of Gybdykes, north-east of Masham, over the Millstone Grit of Mickley and Azerley; thence across the Magnesian Limestone and Millstone Grit of the country west and south of Ripon; the Millstone Grit of Killinghall; the Millstone Grit and Yoredale Rocks of the Harrogate anticlinal; the Millstone Grit of Follifoot Ridge, Spofforth Haggs, Barrowby Grange, the neighbourhood of Harewood, Wike, and Shadwell; the Magnesian Limestone of Ash Bank, near Roundhay Grange; the Lower Coal Measures of Seacroft; and the Middle Coal Measures of Austhorpe and Swillington, to the Alluvial Flat of the River Aire at Mickle-town.
- WILSON, E. On the Permians of the North-East of England (at their southern margin) and their Relations to the under and overlying Formations. *Quart. Journ. Geol. Soc.*, vol. xxxii., pp. 533-537.
- WOODWARD, H. B. The Geology of England and Wales. 8vo. *London*. Ed. 2, 1887.

1877. ARMSTRONG, J. L. Harrogate Handbook and Visitor's Vade Mecum. [Analysis of waters.] Ed. 2. Edition 5 and 6, no date.
- BEVAN, G. P. Tourist's Guide to the West Riding of Yorkshire. [Geology, pp. 3, 4.] 8vo. *London*. Ed. 2, 8vo., 1880. Ed. 4 8vo., 1884. Ed. 5, 8vo., 1889. Ed. 6, 8vo., 1894.
- DE RANCE, C. E. Second Report . . . on the Circulation of Underground Waters, &c. [Boroughbridge.] *Rep. Brit. Assoc.*, for 1876, p. 106.
- LUCAS, J. Sheet 118 (Aldfield) of the Geological Survey Map of Yorkshire (6 inches to a mile). MS. in the Geological Survey Office. [1877 ?].
1878. DAKYNS, J. R., J. LUCAS, C. FOX-STRANGWAYS, R. RUSSELL, W. H. DALTON, and W. GUNN. Sheet 92, S.E. (Bradford, Bingley, Keighley, Skipton, Ilkley, Otley) of the Map of the Geological Survey of England and Wales (1 inch to a mile).
- DAVIS, J. W. Unconformability of the Permian Limestone to the Red Rocks west of its escarpment in Central Yorkshire. *Proc. Yorksh. Geol. Soc.*, vol. vi., pt. iv., pp. 280-308.
- DAVIS, J. W., and F. A. LEES. West Yorkshire: An Account of its Geology, Physical Geography, Climatology and Botany. Part I., Geology, by J. W. Davis. Part II., Physical Geography and Botanical Topography, by J. W. Davis and F. Arnold Lees. [Bibliography, pp. xiii.-xl.] 8vo. *London*.
- DE RANCE, C. E. On the Palaeozoic and Secondary Rocks of England as a source of Water Supply. *Trans. Manchester Geol. Soc.*, vol. xiv., pp. 403-440, plate. Also under different title. 8vo. *Manchester*.
- GREEN, A. H. Explanations of Horizontal Sections, Sheet 99 and Sheet 100. *Geological Survey*. 8vo. *London*.
- GREEN, A. H., R. RUSSELL and others. Geology of the Yorkshire Coalfield. [Harrogate anticline, p. 488.] *Memoirs of the Geological Survey*. 8vo. *London*.
- HARRISON, W. J. Geology of the Counties of England. West Riding of Yorkshire. *Kelly's Post Office Directory*. 4to. *London*.
- STRANGWAYS, C. FOX-. Sheets 121 (Easingwold, Raskelf) and 122 (Crayke, Stillington, Brandsby) of the Geological Survey Map of Yorkshire (6 inches to a mile). MSS. in the Geological Survey Office.
- TUTE, Rev. J. S. Notes on the Glacial Drift near Ripon. *Proc. Yorksh. Geol. Soc.* for 1877, vol. vi., pt. iv., pp. 210-214.
- WARING, E. J. Bibliotheca Therapeutica, or Bibliography of Therapeutics, chiefly in reference to Articles of the Materia Medica, . . . [List of titles on mineral waters. Vol. ii., 1879, p. 775.] 2 vols. 8vo. *London*.
1879. BLAKE, Rev. J. F. The Geological History of East Yorkshire. [Harrogate anticline, p. 16.] *Proc. Yorksh. Geol. Soc.* for 1878, vol. vii., pt. i., pp. 15-29.
- CAMERON, A. C. G. Ripon Swallow-holes. *Geol. Mag.*, dec. ii., vol. vi., p. 575.
- DAKYNS, J. R., J. LUCAS, W. H. DALTON, J. G. GOODCHILD, and W. GUNN. Sheet 97 S.E. (Bedale, Masham, Aysgarth) of the Map of the Geological Survey of England and Wales (1 inch to a mile).
- DAVIS, J. W. Plumpton Rocks. *Proc. Yorkshire Geol. Soc.*, vol. vii., pt. ii., pp. 196, 197.
- HULL, Prof. E. The Age of the Pennine Chain. *Geol. Mag.*, dec. ii., vol. vi., pp. 573, 574.
- LEWIS, A. L. The "Devil's Arrows," Yorkshire. *Journ. Anthropological Inst.*, vol. viii., pp. 180-183.
- TUTE, J. S. On an Orthoceras of the Millstone Grit. *Proc. Yorksh. Geol. Soc.* for 1878, vol. vii., pt. i., p. 82. See 1873.

1879. WILSON, E. The Age of the Pennine Chain. *Geol. Mag.*, dec. ii., vol. vi., pp. 500-504. *Midl. Nat.*, vol. iii., pp. 1-4 (1880). *Rep. Brit. Assoc.* for 1879, pp. 343, 344.
1880. CAMERON, A. C. G. Blowing Wells [in Bunter Sandstone near Northallerton.] *Geol. Mag.*, dec. ii., vol. vii., pp. 95, 96.
- GASCOIGNE, R. The Age of the Pennine Chain. *Geol. Mag.*, dec. ii., vol. vii., p. 187.
- HULL, Prof. E. The Age of the Pennine Chain. *Ibid.*, pp. 185-187.
- MACKINTOSH, D. On the Correlation of the Drift-deposits of the North-west of England with those of the Midland and Eastern Counties [Drift near Ripon, p. 185.] *Quart. Journ. Geol. Soc.*, vol. xxxvi., pp. 178-188.
- TEALL, J. J. H. The Pennine Chain [Criticism of Mr. Wilson and Prof. Hull on the age of the Pennine Chain.] *Geol. Mag.*, dec. ii., vol. vii., pp. 92, 93.
- WILSON, E. The Age of the Pennine Chain. [Letter in answer to Prof. Hull.] *Geol. Mag.*, dec. ii., vol. ii., pp. 93-95.
- WOOD, S. V. The Newer Pliocene Period in England. *Quart. Journ. Geol. Soc.*, vol. xxxvi., pp. 457-528.
1881. BIRD, C. A Short Sketch of the Geology of Yorkshire. 8vo. *London*.
- COLEMAN, J. Report of the Royal Commission on Agriculture. (Parl. Rep.). Fol. *London*.
- DAVIS, R. H. The ancient Alum Well at Harrogate. *Journ. Chem. Soc.*, vol. xxxix., pp. 19, 20.
- FAIRLEY, T. On the Blowing Wells near Northallerton. *Chem. News*, vol. xlv., p. 242. *Proc. Yorksh. Geol. Soc.* for 1881, vol. vii., pt. iv., pp. 409-421, 1882. *Rep. Brit. Assoc.* for 1881, pp. 544, 545; Analyses, pp. 601, 602 (1882).
- OLIVER, G. The Geology of Harrogate. The Syllabus of a Field-day with the Geologists of the British Association; Harrogate, September 3rd, 1881. Pp. 15. 12mo. *Harrogate*.
- The Harrogate Waters. Data Chemical and Therapeutical, with notes on the Climate of Harrogate. 8vo. *London*.
- THORPE, T. E. Contributions to the History of the Mineral Waters of Yorkshire. Analyses by C. H. BOTHAMLEY, A. E. WILSON, H. INGLE, CAROLINE L. KENNEDY, and MARGARET N. JOHNSTONE. *Journ. Chem. Soc.*, vol. xxxix., pp. 497-516. Also Reprint. Pp. 20. 8vo.
- WILSON, E. The Permian Formation in the North-east of England. *Midl. Nat.*, vol. iv., pp. 97-101, 121-124, 187-191, 201-208, pls. vi.-ix.
1882. BRADSHAW, B. Dictionary of Mineral Waters, Climatic Health Resorts, Sea Baths, and Hydropathic Establishments of the World. [Harrogate, p. 76.] 12mo. *London*. Ed. 4, Pp. lxxxiii., 408. 18mo. *London*, 1888. Another Ed. 1892. Reprint, 1893.
- CAMERON, A. C. G. On Subsidences over the Permian Boundary between Hartlepool and Ripon. *Proc. Yorksh. Geol. Soc.* for 1881, vol. vii., pt. iv, pp. 342-351. *Rep. Brit. Assoc.*, for 1881, p. 617.
- DAKYNs, J. R., and C. FOX-STRANGWAYS. Sheet 174 (York) of the Geological Survey Map of Yorkshire (6 inches to a mile). Drift edition. MS. in the Geological Survey Office.
- DE RANCE, C. E. The Water Supply of England and Wales; its Geology, Underground Circulation, Surface Distribution and Statistics. [Knaresborough, Ripon and Harrogate.] 8vo. *London*.
- HARRISON, W. J. Geology of the Counties of England and of North and South Wales. 8vo. *London*.
- HULL, Prof. E. Palæo-Geological and Geographical Maps of the British Isles and adjoining parts of the Continent of Europe. *Trans. Roy. Dublin Soc.*, n.s., vol. i., pt. xix., pp. 257-296.

1882. LUCAS, J. Vestiges of the Ancient Forest on part of the Pennine Chain. *Proc. Yorksh. Geol. Soc.*, vol. vii., pt. iv., pp. 368-373.
- STRANGWAYS, C. FOX-. Sheets 93, N.E. (York) and 96, S.E. (Malton) of the Map of the Geological Survey of England and Wales (1 inch to 1 mile).
- WEBER, H. Mineral Waters. Quain's *Dictionary of Medicine*, pp. 985-992. Ed. 2, pp. 139-147, 1894. Ed. 3, 1902.
- WILSON, J. H. Wilson's Dictionary of Harrogate. [Geology, pp. 44, 45.] 8vo. *Harrogate*.
1883. HARDWICKE, H. J. Health Resorts and Spas; or Climatic and Hygienic Treatment of Disease. [Harrogate, pp. 59, 60.] Pp. viii., 192. 8vo. *London*.
- HUDLESTON, W. H. Excursion to the West Riding of Yorkshire. *Proc. Geol. Assoc.*, vol. vii., pp. 420-438; *Proc. Yorksh. Geol. Soc.*, vol. viii., pt. i., pp. 113-123.
- HUDLESTON, W. H., and J. W. DAVIS. Excursion to the West Riding of Yorkshire. *Proc. Yorksh. Geol. Soc.* for 1882, vol. viii., pt. i., pp. 123-135.
- READE, T. M. A Traverse of the Yorkshire Drift. [Glaciation of the Vale of York.] *Proc. Liverpool Geol. Soc.* for 1882, vol. iv., pt. v., pp. 364-380.
- TICHBORNE, C. R. C., and M. P. JAMES. The Mineral Waters of Europe. [Harrogate, pp. 132-169.] 8vo. *London*.
1884. DAVIS, R. H. Report upon the Analytical Examination of all the Sulphur Springs belonging to the Harrogate Improvement Commissioners. Pp. 15. 8vo. *Harrogate*.
- ELLIS, R. A Medical Guide to the Principal Health Resorts of Northern England, with new chapters on Whitby, Scarborough, Redcar, Saltburn, Harrogate, &c. [Geology, pp. 137, 138; Analyses, p. 139.] Pp. 175. 8vo. *London*.
- HOWELL, H. H., C. FOX-STRANGWAYS, G. BARROW, and A. C. G. CAMERON. Sheet 96, S.W. (Thirsk) of the Map of the Geological Survey (1 inch to 1 mile).
- MILES, C. E. Mineral Springs. [General conditions.] *Trans. Liverpool Geol. Assoc.*, vol. iv., pp. 47-59.
- STRANGWAYS, C. FOX-. The Geology of the Country North-east of York and South of Malton. (Explanation of Quarter-sheet 93, N.E.). *Memoirs of the Geological Survey*. 8vo. *London*.
- TUTE, REV. J. S. On the Sequence of the Permian Rocks near Ripon. *Proc. Yorksh. Geol. Soc.* for 1883, vol. viii., pt. ii., pp. 218-220.
1885. ADAMSON, S. A. The Yorkshire Naturalists' Union at Borough-bridge. [Report on Geological Excursion.] *Naturalist*, vol. x. p. 281.
- AIRY, Dr. H. Report to the Local Government Board on a Prevalence of Typhoid Fever in York. [Soils, Analysis of water, p. 6.] (No. 4.) Pp. 12.
- ANON. Excursion to Brimham Rocks, May 16th, 1885. *Trans. Leeds Geol. Assoc.* Part I., 1883-1885, pp. 38, 39.
- ATKINSON, D. H. Ralph Thoresby the Topographer: His Town and Times. [History of Harrogate Springs. Full account of St. Mungo's Well, pp. 144, 197.] 2 vols. 8vo. *Leeds*.
- CARTER, R. On the Mineral Wells at Harrogate. *Proc. Yorksh. Geol. Soc.* for 1884, vol. viii., pt. iii., pp. 313-319.
- DAKYNs, J. R., C. FOX-STRANGWAYS, and A. C. G. CAMERON. Sheet 93, S.E. (York and Selby) of the Map of the Geological Survey (1 inch to 1 mile).
- DAVIS, R. H. The Mineral Wealth of Harrogate. *Proc. Yorksh. Geol. Soc.* for 1884, vol. viii., pt. iii., pp. 357-366.
- HOLGATE, B. Excursion to Pateley Bridge, October 24th, 1884. [Valley of the Nidd.] *Trans. Leeds Geol. Assoc.*, Part I pp. 34-36.

- 1885 OLIVER, Dr. G. The Mineral Springs of the Grand Anticlinal of the West Riding: A few Chemico-Geological Notes. *Proc. Yorksh. Geol. Soc.* for 1884, vol. viii., pt. iii., pp. 336-356.
- STRANGWAYS, C. FOX-. The Harrogate Wells, or the Mineral Waters of Harrogate geologically considered. *Ibid.*, pp. 319-335.
- SWBETING, R. D. R. Report to the Local Government Board on the Prevalence of Diphtheria in the Whixley Sub-district of the Great Ouseburn Registration District. (No. 9.)
- VINE, G. R. Further notes on new species, and other Yorkshire Carboniferous Fossil Polyzoa described by Professor John Phillips. [*Calamopora tumida* from Harrogate.] *Proc. Yorksh. Geol. Soc.*, for 1884, vol. viii., pt. iii., pp. 377-393.
- WHITELEY, R. L. Analysis of the Kissingen Saline Chalybeate Water, 1883 [Harrogate], as compared with analyses in 1845, 1867, and 1879. *Ibid.*, pp. 366-370.
- YEO, Dr. J. B. Climate and Health Resorts. [Harrogate, pp. 631, 632.] Pp. xv., 660. 8vo. London. (A new edition of Health Resorts and their Uses. Pp. xi., 316, 1882.) Ed. 3. Pp. xiv., 674. 1890.
1886. STRANGWAYS, C. FOX-, A. C. G. CAMERON, and G. BARROW. The Geology of the Country around Northallerton and Thirsk. (Explanations of Quarter-sheets 96, N.W., and 96, S.W.) *Memoirs of the Geological Survey* 8vo. London.
- TUTE, Rev. J. S. Note on *Spirangium carbonarium*, Schimper. *Proc. Yorksh. Geol. Soc.* for 1885, vol. ix., pt. i., p. 53.
1887. HINDE, G. J. On the Character of the Beds of Chert in the Carboniferous Limestone of Yorkshire [which occur in the chert beds of Harrogate]. *Nature*, April 21st, 1887, vol. xxxv., p. 582.
- LEWIS, H. CARVILL. Comparative Studies upon the Glaciation of North America, Great Britain and Ireland. [Vale of York.] *Geol. Mag.*, dec. iii., vol. iv., pp. 28-32. *Rep. Brit. Assoc.* for 1886, pp. 632-635.
- On some important Extra-Morainic Lakes in Central England, North America, and elsewhere, during the Period of Maximum Glaciation, and on the Origin of Extra-Morainic Boulder-clay. [Lake Humber in the Vale of York.] *Geol. Mag.*, dec. iii., vol. iv., pp. 515-517. *Science Gossip*, vol. xxiii. No. 275. Nov., 1887, p. 262. *Rep. Brit. Assoc.* for 1886, pp. 692, 693.
- MARR, J. E. The Work of Ice-sheets. [Pennine Chain.] *Geol. Mag.*, dec. iii., vol. iv., pp. 151-155.
- TUTE, Rev. J. S. The Cayton Gill Beds. *Proc. Yorksh. Geol. Soc.* for 1886, vol. ix., pt. ii., pp. 265-267.
1888. ANON. (H. A. A., of Hull.) Harrogate and Dinsdale-on-Tees. [Comparison of the two places. Analysis of Dinsdale Spring.] *Research*, Sept., 1888, vol. i., p. 46.
- ANON. (T. F. H[ENDERSON].) York. [General account of the geology, physical features, minerals, &c., of the county]. *Ency. Brit.*, Ed. 9, vol. xxiv., p. 746.
- ADAMSON, S. A. The Yorkshire Boulder Committee and its second year's work. [Stillington, p. 333; Cundall, p. 348.] *Naturalist*, pp. 332-348.
- BRITTON, T. Harrogate as a Winter Health Resort: being the Presidential Address to the Yorkshire Association of Officers of Health, March 13th, 1888. [Section showing geological structure.] Pp. 8. 8vo. Harrogate. Reprinted from the *Harrogate Advertiser*, March 17th.
- CROSSKEY, H. W. Fifteenth Report of the Committee . . . appointed for the purpose of recording the position, height above the sea, lithological character, size, and origin of the Erratic Blocks of England, Wales and Ireland, reporting the matters of interest connected with the same, and taking measures for their preservation [Ingleby Greenhow, Whorlton, Baldersby Park Hutton]. *Rep. Brit. Assoc.* for 1887 pp. 236-247.

- HOLGATE, B. The Magnesian Limestones of Yorkshire. *Trans. Leeds Geol. Assoc.*, 1888, pt. iv., pp. 182-184.
- LEES, F. A. The Flora of West Yorkshire, with a sketch of the Climatology and Lithology in connection therewith. [Lithology, pp. 65-84, and map]. Pp. 843. 8vo. *London*.
- PLATNAUER, H. M. Note on some Crystals of Celestine [from the bed of the Nidd near Knaresborough]. *Ann. Rep. Yorksh. Phil. Soc.* for 1887, p. 34.
- SQUIRE, Dr. W. The Sulphur Springs of Great Britain and their Therapeutic Action. [The situation of Harrogate and Dinsdale geologically similar.] *Lancet*, Aug. 4, vol. ii., pp. 201-203.
- SUMMERFIELD, Rev. R. A. North Stainley, near Ripon. [Boulders and Drift gravels.] *Naturalist*, p. 345.
- TAIT, M. Yorkshire: its Scenes, Lore and Legends, with Geological Map by F. D. KING. [Geology, pp. 2-7.] Pp. 100, 12mo. *Leeds*.
- TATE, A. N. Scientific aspects of Health Resorts. [Geological notes and illustrations.] *Research*, vol. i., pp. 5-7.
- TUTE, Rev. J. S. Note on the occurrence of Lingula in the Millstone Grit Series, west of Ripon. *Proc. Yorksh. Geol. Soc.* for 1887, vol. ix., pt. iii., p. 425.
1889. ADAMSON, S. A. The Yorkshire Boulder Committee and its third year's work. [Tanfield, Staveley, Arkendale, Claro Hill, &c.] *Naturalist*, pp. 293-313.
- The Yorkshire Naturalists' Union at Harrogate. *Ibid.*, pp. 235-244.
- Yorkshire Naturalists' Union. [Excursion to Ripley, via Clint and Hampsthwaite to Harrogate.] *Research*, vol. ii., pp. 69, 70. *Trans. Leeds Geol. Assoc.* for 1889, part v., pp. 68-71 (1890).
- BAKER, J. G. North Yorkshire: Studies of its Botany, Geology, Climate, and Physical Geography. [Geology corrected and revised by J. E. CLARKE, assisted by H. M. PLATNAUER, pp. 5-45.] *Trans. Yorksh. Nat. Union*, part xi., for 1885; and 8vo. *Leeds*, 1889.
- CROSSKEY, H. W. Sixteenth Report . . . on Erratic Blocks. [Ingleby Greenhow, Stillington, Cundall, North Otterington, Thornton le Moor, Baldersby.] *Rep. Brit. Assoc.* for 1888, pp. 101-124.
- DAKYNs, J. R., R. H. TIDDEMAN, J. LUCAS, C. FOX-STRANGWAYS, W. H. DALTON. Sheet 92 N.E. (Pateley Bridge, Burnsall, Grassington) of the Map of the Geological Survey of England and Wales (1 inch to 1 mile).
- DALTON, W. H. A list of Works referring to British Mineral and Thermal Waters. 8vo. *London. Rep. Brit. Assoc.* for 1888.
- DAVIS, R. H. Harrogate as a Health Resort. ("Harrogate and its Spas" on outside cover.) Pp. 14, 8vo. *Harrogate*.
- HOLGATE, B. On the Magnesian Limestones of Yorkshire. (Abstract of a lecture.) *Trans. Leeds Geol. Assoc.* for 1888, part iv., pp. 182-184.
1890. ANON. The Harrogate Pictorial. [Geology, pp. 9, 57 and 58.] 4to. *London*. Pp. 64. [1890].
- BARRY, Dr. F. W. Report to the Local Government Board on the General Sanitary Condition of the Easingwold Rural Sanitary District. (No. 55.) Pp. 14.
- CROSSKEY, H. W. Seventeenth Report. . . on Erratic Blocks. [Haddockstones.] *Rep. Brit. Assoc.* for 1889, pp. 115-127.
- MITCHELL, T. C. On the Drift Deposits of the Vale of Mowbray. *Proc. Yorksh. Geol. Soc.* for 1889, vol. xi., pt. ii., pp. 177-182.
- RÜCKER, A. W., and T. E. THORPE. Preliminary Note on Supplemental Magnetic Surveys of Special Districts in the British Isles. [Harrogate, p. 444.] *Proc. Roy. Soc.*, vol. xlvii., p. 443.
- On the relations between the Geological Constitution and the Magnetic State of the British Isles. *Rep. Brit. Assoc.* for 1889, p. 586. Under different title. *Nature*, vol. lxi. p. 598.

1890. TUTE, Rev. J. S. Excursion to the Haddockstones and District. *Trans. Leeds. Geol. Assoc.*, pt. v., pp. 62-65.
 ——— Notes on some singular Cavities in the Magnesian Limestone. *Proc. Yorksh. Geol. Soc.* for 1889, vol. xi., pt. ii., pp. 182-184.
- 1891 ANON. Inland Watering Places: Being Descriptions of the Spas of Great Britain and Ireland, their Mineral Waters and their Medicinal Value, and the attractions which the various resorts offer to invalids and other visitors. [Harrogate, analyses, &c., pp. 94-104.] Pp. 211. 8vo. *London*.
 BOTHAMLEY, C. H. The Sulphur Waters of Yorkshire. [Harrogate and Askern.] *Rep. Brit. Assoc.* for 1890, p. 779.
 BREARE, W. H. First edition of Thorpe's New Illustrated Guide to Harrogate and District. To which is added Walks and Footpaths around Harrogate, and the Geology of Harrogate by W. GRAINGE. 8vo. *Harrogate*. Other editions, 1899 and 1908.
 DE RANCE, C. E. Notes on borings for water and salt in the County of York. [Well sections in the Vale of York.] *Proc. Yorksh. Geol. Soc.* for 1889, vol. xi., pt. iii., pp. 424-440.
 RÜCKER, A. W., and T. E. THORPE. A Magnetic Survey of the British Isles for the Epoch of Jan. 1, 1886. *Phil. Trans.*, vol. 181, B., pp. 53-328, pls. i-xiv.
 WHEATER, W. Handbook for Tourists in Yorkshire, and Complete History of the County. [History of Harrogate Wells, p. 337.] 2 vols. 4to. *Leeds*.
1892. CHADWICK, S. The Yorkshire Boulder Committee and its Fourth Year's Work. [Erratics from near Thirsk.] *Naturalist*, pp. 155-158.
 KENDALL, P. F. The Supposed Glacial Submergence. [Evidence against submergence in Glacial times.] *Trans. Leeds. Geol. Assoc.*, part vii., 1891-2, pp. 43-47.
 LAVIS, H. J. JOHNSTON. The Prescriber's Guide to the Harrogate Mineral Waters. [Tables of Analyses.] 8vo. *London*.
 RUSSELL, A. G. Harrogate an inland Health Resort. [History, Meteorology, Waters, &c.] 2 illustrations. *Journ. Brit. For. Health Resorts*, n. s., vol. iii., No. 2, pp. 51-56.
 TUTE, J. S. A Permian Conglomerate Bed at Markington. [Contains pebbles of Carboniferous Limestone and Sandstone.] *Proc. Yorksh. Geol. Soc.* for 1891, vol. xii., pt. i., pp. 72-73.
 WRIGHT, G. F. Man and the Glacial Period. (Ancient Glaciers in Eastern Hemisphere, by P. F. KENDALL, pp. 137-181. Reprinted, *Naturalist*, Sept. 1893, pp. 265-279.) Pp. xiv., 385. 8vo. *London*. Ed. 2, 1893.
- 1893 CROSSKEY, H. W. Twentieth Report . . . on Erratic Blocks. [Pickhill and Sinderby near Thirsk, p. 268.] *Rep. Brit. Assoc.* for 1892, pp. 267-289.
 KENDALL, P. F. The Cause of the Ice Age. [Amplification of paper by P. F. KENDALL and J. W. GRAY, *Rep. Brit. Assoc.* for 1892, p. 708.] *Trans. Leeds Geol. Assoc.*, part viii., 1892-3, pp. 53-70.
 LIDDELL, Dr. J. The Mineral Waters of Harrogate. [Analyses.] 8vo. *Edinburgh and London*.
 SWAIN, W. T. Popular Guide to Boroughbridge and the surrounding District including Ripon, York, Harrogate, Knaresborough, Skelton, Myton, Hackfall, Helmsley, Coxwold, Whixley Marston Moor, Aldbrough, &c.; and containing sketches of the principal places of interest. [Devil's Arrows, pp. 33-37.] Pp. 75. 8vo. *Boroughbridge*.
 TATE, T. The Yorkshire Boulder Committee and its seventh year's work. [Erratics from near Masham, Ripon and Thirsk.] *Naturalist*, pp. 363-368.
 THOMPSON, T. W. Report of the Local Government Board on the General Sanitary Condition of the York Rural Sanitary District (No. 65).

1893. TUTE, Rev. J. S. On some singular nodules in the Magnesian Limestone. [Wormald Green.] *Proc. Yorksh. Geol. Soc.*, vol. xii., pt. iii., pp. 245, 246.
- The Occurrence of a Tooth of a Mastodon in the Glacial Drift. *Ibid.*, p. 246.
- ROBERTS, A. The Mineral Waters at Harrogate. [Notes on new analyses.] *Monthly Homœopathic Review*, vol. xxxvii., pp. 272–286. Reprinted under the title “The Harrogate Mineral Waters and Homœopathy.” [Chemical notes, p. 4.] Pp. 16, 8vo. *London*.
1894. BOTHAMLEY, C. H. The Mineral Waters of Askern in Yorkshire. [Analyses compared with those of Harrogate.] *Proc. Yorksh. Geol. Soc.*, vol. xii., pt. v., pp. 347–360.
- CROSSKEY, H. W. Twenty-first Report . . . on Erratic Blocks. [Topcliffe, York, p. 523.] *Rep. Brit. Assoc.* for 1893, pp. 514–523.
- See H. Carvill Lewis.
- DAKYN, J. R. A Sketch of the Geology of Nidderdale and the Washburn North of Blubberhouses. [Anticlines west of Harrogate.] *Proc. Yorksh. Geol. Soc.*, vol. xii., pt. iv., pp. 294–299.
- KENDALL, P. F. The Glaciation of Yorkshire. [Map of the Vale of York.] *Proc. Yorksh. Geol. Soc.*, vol. xii. pt. iv., pp. 306–318.
- LEWIS, H. CARVILL. Papers and notes on the Glacial Geology of Great Britain and Ireland. [Glaciation of Yorkshire, pp. 172–247.] Introduction, pp. xxxi.–lxxxii., by H. W. CROSSKEY. 8vo. *London*.
- PLATNAUER, H. M. Borings made in the neighbourhood of York. [Raskelf and Huby in the Vale of York.] *Ann. Rep. York Phil. Soc.* for 1893, pp. 56, 57.
- ROBERTS, A. The Harrogate Mineral Waters. New Analyses with Observations. *Monthly Homœopathic Review*, vol. xxxviii., pp. 443, 444. Also Pp. 48. 8vo. *Harrogate*.
- SPEIGHT, H. Nidderdale and the Garden of the Nidd: A Yorkshire Rhineland. Being a complete account, Historical, Scientific, and Descriptive of the beautiful valley of the Nidd. [Geological and Natural History notes.] 8vo. *London*.
- TATE, T. The Yorkshire Boulder Committee and its Eighth Year's Work. [Erratics from Kirklington and Baldersby.] *Naturalist*, pp. 297–303.
1895. ANON. (W. F. B.) Yorkshire Naturalists at Knaresborough. [Report of Geological excursion by T. TATE, pp. 148, 149.] *Naturalist*, pp. 145–149.
- BLACK, J. GORDON. Health Resorts. Harrogate. *Quart. Med. Journ.*, vol. vi., pp. 47–59.
- GARROD, A. E., and others. The Climates and Baths of Great Britain, being the report of the Committee of the Royal Medical and Chirurgical Society of London. [Harrogate by M. MORRIS and F. PENROSE, pp. 540–557.] 2 vols., 8vo. *London*. Vol. ii., 1902.
- KENDALL, P. F. Twenty-second Report . . . on Erratic Blocks. [Baldersby and Kirklington, p. 429.] *Rep. Brit. Assoc.* for 1895, pp. 426–430.
- Twenty-third Report. [Baldersby.] *Ibid.*, pp. 430–436.
- MYRTLE, A. S. Curative properties of the Harrogate Waters. (*Brit. Med. Assoc.*, Aug., 1895.) Pp. 14, 8vo. *Harrogate*.
- TATE, T. The Yorkshire Boulder Committee and its Ninth Year's Work. [Baldersby.] *Naturalist*, pp. 339–345.
1896. BURRELL, B. A. Analysis of the Water from the Dropping Well at Knaresborough in Yorkshire. *Journ. Chem. Soc.*, vol. lxi., pp. 536–539.
- GEOLOGICAL SURVEY OF ENGLAND AND WALES. General Geological Map of England and Wales. Sheet 5. (Scale 4 miles to 1 inch.)

1896. HOLROYD, W. F., and J. BARNES. On the Stratified Clay of Strath-earn, and on the Imatra or "Fairy Stones" found therein. [Exhibiting specimens from the Permian Rocks near Ripon.] *Trans. Manchester. Geol. Soc.*, vol. xxiv., pp. 110-112.
- KENDALL, P. F. First Report . . . on Erratic Blocks. [Harrogate, Bilborough, &c., pp. 372, 373.] *Rep. Brit. Assoc.* for 1896, pp. 366-377.
- On some Post-Pliocene Changes of Physical Geography in Yorkshire. [Diversion of the Nidd Valley.] *Ibid.*, pp. 801, 802; *Nature*, vol. liv., p. 586; *Glacialist Mag.*, vol. iv., pt. ii., pp. 82-84.
- Notes on the Superficial Geology of the Vale of York [Moraines of the Vale of York.] *Proc. Yorksh. Geol. Soc.*, vol. xiii., pt. i., pp. 89-91. Abstract, *Glacialist Mag.*, vol. iv., pt. ii., p. 94.
- READE, T. MELLARD. British Geology in Relation to Earth-Folding and Faulting. (Presidential Address, Oct. 1895). *Proc. Liverpool Geol. Soc.*, vol. vii., pp. 363-377.
- R[EYNOLDS,] R. Biographical Notice of Richard Carter. *Proc. Yorkshire Geol. Soc.*, vol. xiii., pt. i., pp. 92-94.
- STRANGWAYS, C. FOX-. Glacial Phenomena near York. *Ibid.*, pp. 15-20.
- THRESH, J. C. Water and Water Supplies. [Ripon, York, Knaresborough, Ed. 3, p. 106.] 8vo. *London*. Ed. 2, 1896. Ed. 3, 1901.
- WEBER, H. and F. P. The Spas and Mineral Waters of Europe with notes on Balneo-Therapeutic management in various diseases and morbid conditions. [Harrogate, pp. 216-219.] 8vo. *London*.
1897. BURRELL, B. A. A History of the Dropping Well at Knaresborough with the Analysis of the Water. [History of the Harrogate Springs.] *Proc. Yorksh. Geol. Soc.*, vol. xiii., pt. ii., pp. 135-143.
1898. ANON. Health Resorts. Harrogate. *Gentlemen's Journal*, Nov. 15, vol. xvi., No. cxlvi., p. 3468.
- BLACK, J. GORDON. The immediate future of the Spa. *Harrogate Herald*, July, 12th. Also Pp. 15, 8vo. *Harrogate*.
- BURRELL, B. A. The composition of the spar occurring in Mother Shipton's Cave, Knaresborough. *Proc. Yorksh. Geol. Soc.*, vol. xiii., pt. iii., pp. 284, 285.
- FAIRLEY, T. On the Water Supplies of Yorkshire. [Analyses of water from Harrogate, Thirsk, Ripon, &c.] *Journ. Fed. Inst. Brewing*, vol. iv., No. 5, pp. 393-405.
- HUDLESTON, W. H. In Memoriam. John Stanley Tute. [Reference to his geological work in the Ripon district.] *Proc. Yorksh. Geol. Soc.*, vol. xiii., pt. iii., pp. 353-355.
- KENDALL, P. F. The Rocks of Yorkshire as a Source of Water Supply. *Journ. San. Inst.* for 1897, vol. xviii., pt. iv., pp. 591-601.
- Second Report. . . . on Erratic Blocks. [Claro Hill, p. 351.] *Rep. Brit. Assoc.* for 1897, pp. 349-352.
- The Physical Geography of Yorkshire. [Abstract of a lecture.] *Trans. Leeds Geol. Assoc.*, part xi., pp. 20-22.
- WEBER, H. and F. P. The Mineral Waters and Health Resorts of Europe. . . . Being a revised and enlarged edition of "The Spas and Mineral Waters of Europe." [Harrogate, pp. 261-263.] 8vo. *London*. Ed. 3, Pp. 833, 1907.
1899. FLETCHER, J. S. A Picturesque History of Yorkshire. Being an Account of the History, Topography and Antiquities of the Cities, Towns and Villages of the County of York, founded on Personal Observations made during many journeys Through the Three Ridings. [Harrogate, vol. ii., pp. 238-245.] 3 vols., 4to. *London*. Another Ed., 6 vols. 8vo. *London*, 1903-04.

1899. GRAINGE, W. D'OYLY. Illustrated Handbook of the Baths and Springs of Harrogate. Pp. 102, Map and illustrations, 8vo *Harrogate*.
- PAUL, G. Harrogate illustrated, with Notes on its Environs. [History and analyses of the waters.] (Mate's illustrated guides). 8vo. *Bournemouth*. Ed. 4, 1905.
- SMITH, F. W. The Natural Waters of Harrogate, Chemically, Therapeutically and Clinically considered, with reference to their application by drinking and bathing; by the light of fresh analysis, and by examination of the blood. [Geology, pp. 26-28. Chemical analysis by C. F. TOWNSEND, pp. 29-35.] Pp. 101, Map, 8vo. *London*.
1900. ANON. [J. V. ELSDEN and A. GREENWELL.] The Mineral Industry of the United Kingdom, VI. Yorkshire. [Map of Yorkshire, 1 inch to 13 miles; North-East Yorkshire, 1 inch to 4 miles.] *Quarry*, vol. v., pp. 112-120, 145-157, 195-207, 245-259, 309-322.
- ANON. The Court Guide and County Blue Book of the West Riding of Yorkshire. [Geology by B. HOLGATE, pp. 69-88.] 8vo. *London*.
- DWERRYHOUSE, A. R. The New Red Series of England. [Quarries at Knaresborough.] *Trans. Leeds. Geol. Assoc.*, part xii., pp. 28-31.
- HOWARTH, J. H. What we know of the Boulders of Yorkshire. *Ibid.*, pp. 5-8.
- Some Yorkshire Erratics and how to recognise them. *Ibid.*, p. 14.
- KENDALL, P. F. On the Glacial Drainage of Yorkshire. [Moraines in the Vale of York.] *Rep. Brit. Assoc. for 1899*, pp. 743, 744.
- The Glacial Lakes and River Channels of Yorkshire. *Trans Leeds Geol. Assoc.*, part xii., pp. 27, 28.
- PAUL, G. Discovery of a very rare fossil in Harrogate. (Pleuro-nautilus nodoso-carinatus, Römer.) *Harrogate Advertiser*, Jan. 6th, p. 5. *Yorkshire Weekly Post*, Jan. 13th.
1901. ACKROYD, W. On the Distribution of Chlorine in West Yorkshire. *Rep. Brit. Assoc. for 1900*, pp. 694, 695.
- On the Circulation of Salt and its Geological Bearings. *Rep. Brit. Assoc. for 1901*, pp. 654-655; *Proc. Yorksh. Geol. Soc.* vol. xiv., pt. iii., pp. 401-421. (1902.)
- Researches on Moorland Waters, Part II. On the Origin of the combined Chlorine. [Widdop.] *Journ. Chem. Soc.*, vol. lxxix., pp. 273, 274.
- ANON. The Court Guide and County Blue Book of the North and East Ridings of Yorkshire. [Geology by H. M. PLATNAUER, pp. 91-113.] 8vo. *London*.
- HIND, WHEELTON. The Geological Succession and Palæontology of the Beds between the Millstone Grit and the Limestone-Massif at Pendle Hill and their Equivalents in other parts of Britain. *Quart. Journ. Geol. Soc.*, vol. lvii., pp. 347-404; In abstract, *Geol. Mag.*, dec. iv., vol. viii., pp. 185, 186; *Nature*, vol. lxxiii., pp. 506, 507.
- LAMPLUGH, G. W. Names for British Ice-sheets of the Glacial Period. *Geol. Mag.*, dec. iv., vol. viii., p. 142.
- LEECH, D. J. Mineral Waters. *Materia Medica, Pharmacy, Pharmacology and Therapeutics*, edited by W. HALE WHITE. [Harrogate, pp. 874-6, 880-1.] 8vo. *Edinburgh and London*. Many editions.
- LEES, F. A. Wetherby revisited by the Yorkshire Naturalists. [Geological notes by E. HAWKESWORTH, pp. 326, 327.] *Naturalist*, pp. 325-332.
- MITCHELL, C. A. Barium in Boston Spa Water. [Analysis.] *Science Gossip*, vol. viii., No 86, July, 1901, p. 54.
- ROBERTS, A. The Use and Abuse of the Harrogate Mineral Waters. [Includes the works published in 1893 and 1894.] Pp. 46 and analyses. 8vo. *Harrogate*.

1902. HARROGATE SEWERAGE SCHEME. Local Government Board Inquiry. March, 1902. Fol. *Harrogate*.
- HIND, W. On the Characters of the Carboniferous Rocks of the Pennine System. *Proc. Yorks. Geol. Soc.*, vol. xiv., pt. iii., pp. 422-464.
- KENDALL P. F. [Sixth] Report . . . on Erratic Blocks. [Brompton near Northallerton, Kirklington, p. 286.] *Rep. Brit. Assoc.* for 1901, pp. 283-288.
- KENDALL, P. F. and J. H. HOWARTH. The Yorkshire Boulder Committee and its Fifteenth Year's Work, 1900-1901. [Kirklington, p. 214.] *Naturalist*, pp. 211-216.
- KENDALL, P. F. Report of Excursion to Coxwold and Kilburn. *Ibid.*, pp. 283, 284.
1903. ANON. (T. S.), Yorkshire Naturalists at Cowthorpe. [Notices of gravel ridges in the Vale of York by E. HAWKESWORTH.] *Naturalist*, pp. 196-200.
- HOWARTH, J. H. Notes on Boulder Markings on Mr. Kendall's Map of the Glacier Lakes in the Cleveland Hills. [Vale of York.] *Proc. Yorksh. Geol. Soc.*, vol. xv., pt. i., pp. 46-51.
- KENDALL, P. F. [Seventh] Report . . . on Erratic Blocks. [Aldfield, Escrick, Coxwold, Kilburn, p. 254.] *Rep. Brit. Assoc.* for 1902, pp. 252-258.
- KENDALL, P. F. and J. H. HOWARTH. The Yorkshire Boulder Committee and its Sixteenth Year's Work. 1901-1902. [Aldfield, Coxwold, Kilburn.] *Naturalist*, pp. 72-77.
- SMITH, DR. W. G. and W. MANN RANKIN. Geographical Distribution of Vegetation in Yorkshire. Part II.: Harrogate and Skipton District. *Geograph. Journ.*, vol. xxii., pp. 149-178. *Scott. Geograph. Mag.*, vol. xix., pp. 417-422.
1904. KAYE, J. R. Report of the County Medical Officer on the Water-Supplies derived or derivable from the New Red Sandstone Formation in the West Riding. [Newton on Ouse, p. 14. Geological Map.] Fol. *Wakefield*. Abstract, *Water*, vol. vi., p. 168.
- KENDALL, P. F. Eighth Report . . . on Erratic Blocks. [Flaxby, Brompton, Thirsk.] *Rep. Brit. Assoc.* for 1903, pp. 231-258.
- KENDALL, P. F. and J. H. HOWARTH. The Yorkshire Boulder Committee and its Seventeenth Year's Work. 1902-1903. [Vale of Mowbray, Flaxby, Brompton.] *Naturalist*, pp. 13-18.
- MILL, H. R. England and Wales viewed geographically. [The Western District, p. 629.] *Geograph. Journ.*, vol. xxiv., pp. 621-636.
- YEO, J. B. The Therapeutics of Mineral Springs and Climates. [Harrogate, pp. 200-203.] 8vo. *London*.
1905. ANON. Harrogate Illustrated with Notes on its environs. [History and account of Mineral Springs.] Ed. 4, 8vo. *Bournemouth*. Ed. 1, 1899.
- ANON. Yorkshire Naturalists at Ripon. [Geological Report by W. L. CARTER, p. 177.] *Naturalist*, pp. 175-182.
- BAIN W. and W. EDGECOMBE. The Physiology and Therapeutics of the Harrogate Waters, Baths and Climate applied to the treatment of Chronic Disease. [Chemical notes.] 8vo. *London*.
- DAVISON, C. Yorkshire Earthquakes. [Records and dates since beginning of 19th century.] *Naturalist*, pp. 26-28.
- JOHNS, COSMO. On Differential Earth Movements during Carboniferous Times, and their significance as factors in determining the Limits of the Yorkshire, Derbyshire and Nottinghamshire Coalfield, *Proc. Yorksh. Geol. Soc.*, vol. xv., pt. iii., pp. 372-379.
- KENDALL, P. F. Ninth Report . . . on Erratic Blocks, [Brompton, Osmotherley, Thirsk.] *Rep. Brit. Assoc.* for 1904 pp. 237-241.
- KENDALL, P. F. and J. H. HOWARTH. The Yorkshire Boulder Committee and its Eighteenth Year's Work, 1903-1904. [Brompton, Osmotherley, Thirsk.] *Naturalist*, pp. 79, 80.

1906. CARTER, W. L. River Capture in Yor shire. [River Nidd, &c.] *Trans. Leeds Geol. Assoc.*, vol. xiii., pp. 40, 41.
- DAVISON, C. The Doncaster Earthquake of April 23rd, 1905. *Quart. Journ. Geol. Soc.*, vol. lxii., pp. 5-12.
- JOHNS, COSMO. The Permian Salt Lake. *Naturalist*, No. 593, pp. 176-178.
- VAUGHAN, A. A Note on the Carboniferous sequence in the neighbourhood of Pateley Bridge. *Proc. Yorksh. Geol. Soc.*, vol. xvi., pt. 1, pp. 55-83.
- WOODWARD, H. On a Carboniferous Trilobite from Angram, in Nidderdale. *Ibid.* pp. 84-86.
1907. CARTER, W. L. Report of the Secretary of the Yorkshire Geological Society. [Diversion of River Valleys, p. 212.] *Proc. Yorksh. Geol. Soc.*, vol. xvi., pt. ii., pp. 205-221.
- HARMER, F. W. On the Origin of Certain Cañon-like Valleys associated with Lake-like Areas of Depression. [Map showing Pleistocene Deposits near Harrogate.] *Quart. Journ. Geol. Soc.*, vol. lxiii., pp. 470-514.
- HIND, DR. WHEELTON. Life Zones in the British Carboniferous Rocks. Part II. The Fossils of the Millstone Grit and Pendleside Series. *Naturalist*, pt. xiv., pp. 17-23 and 90-96.
- KENDALL, P. F. [The Geology of Yorkshire.] *The Victoria History of the County of York*. Pp. 97, 4to. London.
- LAMPLUGH, G. W. On British Drifts and the Interglacial Problem. (Presidential Address). *Rep. Brit. Assoc.* for 1906, pp. 532-558.
- WEBER, H. and F. P. Climatotherapy and Balneotherapy. The Climates and Mineral Water Health Resorts (Spas) of Europe and North Africa, including the general principles of Climato-therapy and Balneotherapy, and hints as to the employment of various physical and dietetic methods. Being a third edition of "The Mineral Waters and Health Resorts of Europe," much enlarged in respect to Medical Climatology. [Harrogate, pp. 545-548; also Bibliography of Mineral Waters, pp. 745-774.] 8vo. London.
1908. HOWARTH, J. H. The Ice-borne Boulders of Yorkshire. *Naturalist*, pp. 97-99, 143-146, 175-180, 219-224, 245-252, and Map.
- LOCKYER, SIR NORMAN. Notes on Ancient British Monuments. [Devil's Arrows at Boroughbridge.] *Nature*, Jan. 16th, vol. lxxvii., p. 250.

DATE UNCERTAIN.

- GRIM, H. Three drawings of the separate stones called Devil's Arrows. MS. in the British Museum. Kaye, v., 15-17*.
- HEYWOOD, A. A Guide to Harrogate and its Waters; with excursions to Harlow Hill, Crimble Viaduct, Knaresborough, Brimham Rocks, Ripon, Studley Park, Fountains Abbey, Harewood, Ripley, &c. Pp. 16. Map. 8vo. Manchester and London. About 1870.
- An Illustrated Guide to Knaresborough, Scriven Park, St. Robert's Cave and places of interest in the neighbourhood, with an account and analysis of the waters of the celebrated Bilton Spa. Pp. 28. 8vo. Manchester and London. About 1889.
- THORPE, J. Visitor's Handbook for Harrogate and Stranger's Companion to all objects of interest in the District; together with a popular description of the Mineral Waters, and a Map of Twenty Miles round Harrogate. [Geology and Analyses]. Ed. 6. 1863. Ed. 10 about 1875. 8vo. Harrogate.

* There are other views of these stones published by J. Flintoff in 1798 in the British Museum Library, K, 44 (27), b, c.

INDEX.

- Abandoned channels, 23, 31.
 Abbey Crag, Knaresborough, 8.
 ACKROYD, W., 91.
 ADAMSON, S. A., 85, 86, 87.
 Age of the rocks, 2.
 Ainthorpe, 22.
 AIRY, H., 85.
 AKERMAN, J. Y., 75.
 Aldborough, 16, 36.
 Aldfield, 14, 22, 31, 33, 45.
 Aldwark, 24.
 ALEXANDER, W., 68.
 ALLEN, B., 65, 66.
 ALLEN, T., 72.
 Allerton Hall, 55.
 Alluvium, 25.
 Almes Cliff, 27.
 ———— Rocks, 44.
 Alne, 22.
 ———— Station, 17.
 Alteration of river courses, 23, 31.
 ALTHAUS, J., 77.
 Amount of salts in the Harrogate Springs, 52.
 Analyses of Chalybeate Waters, 48.
 ———— Harrogate Water Supply, 39.
 ———— Mineral Waters, 33, 34, 35.
 ———— Lime, 36.
 ———— Ripon Water Supply, 40.
 ———— Sulphur Waters, 47.
 ———— York Water Supply, 41.
 Anticlines, 26-28, 30, 45.
 Appletreewick, 50.
 Arkendale, 22, 55.
 Arlington House, near Starbeck, 28.
 ARMSTRONG, J. L., 83.
 ATKINS, J., 67.
 ATKINSON, D. H., 85.
 ATKINSON, J., 71.
 AVELINE, W. T., 79, 80, 81.
Axinus obscurus, 13.
 BAIN, W., 92.
 BAINES, H., 74.
 BAINES, T., 80.
 BAKER, J. G., 78, 87.
 Baldersby, 22.
 BARNES J., 90.
 BARRY, F. W., 87.
 BARROW, G., 85, 86.
 Barsneb, 28.
 BAYNARD, E., 65.
 BAYNES, J., 40.
 Beamsley Beacon, 4, 45.
 BEALEY, A., 76.
 Beaver Dyke, 39.
 Beckwith House, 5, 27.
 ———— Shaw, 45, 46.
 Bedale, 59.
 BENNETT, W., 50, 74, 75.
 BEVAN, G. P., 83.
 Bibliography, 61-93.
 BIGLAND, J., 69.
 Bilborough, 22.
 Bilton, 6, 26, 28, 31, 37, 38, 39.
 Bilton Hall, 14.
 Bilton, near Wetherby, 55.
 BINNEY, E. W., 78.
 BIRD, C., 84.
 Birk Crag, 5, 27, 45.
 ———— Rocks, 44.
 Bishop Monkton, 16.
 Bishopton Mills, Ripon, 22.
 BLACK, A. and C., 79.
 BLACK, J. G., 89, 90.
 BLAKE, J. F., 82, 83.
 BLOME, R., 65.
 Blowing wells, 13, 14.
 Blows Hall, near Ripon, 56.
 Bogs Field, Harrogate, 26, 27, 43, 45.
 ———— Lane, 5.
 ———— Boring, 54.
 Bolton Abbey, 4, 45, 50.
 Bones of Mammalia, 24.
 BOOTH, A., 72.
 Borehole at Alne, 17.
 ———— Bogs Lane, 5, 54.
 Borings and Well Sections, 53-60.
 Boroughbridge, 1, 9, 14, 17, 36, 56.
 BOTHAMLEY, C. H., 84, 88, 89.
 Boulder-clay, 21, 22.
 Boulders in the Drift, 22.
 BRADSHAW, B., 84.
 Brafferton, 17, 24, 56, 57.
 BRAUN, J., 81.
 BREARE, W. H., 88.
 Brearton, 11, 32, 55.
 BRIGGS, H., 75.
 Brinham, 9.
 BRITTON, T., 86.
 Broad Oak Farm, near Cowthorpe, 16.
 Brompton, 22.
 BROWN, R., 69.
 BRUNTON, W., 33.
 BUCHAN, W., 68.
 Building-stone, 9, 16, 35, 36.
 Bunter Sandstone, 16, 17, 30, 36.
 BURRELL, B. A., 34, 89, 90.
 Burton Leonard, 13, 55.
 CALVERT, M., 71, 75.
 CAMDEN, W., 64, 66.

- CAMERON, A. C. G., 17, 83, 84, 85,
86.
Carboniferous Limestone, 44.
Boulders,
22.
Rocks, 4-10.
Carlton Bank, 22.
CARTER, R., 85.
CARTER, W. L., 93.
CARY, G. S., 69.
CASTRO, T. DE, 67.
Cattal, 17, 58.
Station, 16, 24.
Caves in the Limestone, 13.
CAYLEY, G., 33, 69.
Cayton Gill, 21, 22, 31.
Beds, 6, 7, 27, 28.
Celestite, 38.
CHADWICK, S., 88.
Chalybeate Waters, 46, 48, 51.
Channels, Abandoned, 23, 31, 32.
CHARNOCK, J. H., 76.
Chemical constituents of the Harro-
gate Waters, 47-49.
CHURCH, A. H., 78.
CLARKE, J. E., 87.
Claro, 22.
Classification of the strata, 2, 3.
CLAY, J. T., 75.
CLAYTON, Dr., 65.
Clint Quarries, 7.
Coal, 6, 37, 38.
Cold Bath Road, Harrogate, 5, 27.
COLEMAN, J., 84.
Conglomerate, 8, 13.
CONYBEARE, W. D., 71, 73.
Cook, J., 24.
COOKE, G. A., 69.
Copgrove, 35.
Copper-ore, 38.
Cowthorpe, 25.
Coxwold, 22.
Crayke, 20, 30.
Crimpie Beck, 22, 27.
Farm, 27.
River, 31.
Valley, 5, 21.
CROSSKEY, H. W., 86, 87, 88, 89.
Cundall, 22.
CURRY, J., 79.
DAKYNs, J. R., 79, 80, 81, 82, 83, 84,
85, 87, 89.
DALTON, W. H., 82, 83, 87.
DAUBENY, C., 72, 73.
DAVIS, J. W., 83, 85.
DAVIS, R. H., 78, 81, 84, 85, 87.
DAVISON, C., 92, 93.
Dean, The, 31.
DEANE, E., 64.
Deers' horns, 25.
DE LA BECHE, Sir H. T., 72.
Denudation, 31, 32.
Depressions in the Boulder-clay, 24.
Trias, 16, 17.
DE RANCE, C. E., 82, 83, 84, 88.
Devil's Arrows, 9.
Dip of the Harrogate Roadstone
Series, 26, 27.
Dip of the Millstone Grit, 27, 29.
Permian Beds, 28.
DIXON, F. J., 7, 39, 53, 54, 55, 59, 60.
Dole Bank, 9, 31, 32.
Drainage, 1, 31, 32.
DRAKE, F., 66.
Drift, 21, 22, 23.
Dropping Well, 34.
DURAND-FARDEL, M., 77.
DWERRYHOUSE, A. R., 91.
Easingwold, 1, 17, 18, 19, 20, 30, 36,
38, 40.
Economic Geology, 33-41.
EDGEcombe, W., 92.
Elephas primigenius, 24.
Elevation of the country, 1, 2, 30, 31.
ELLIOT, J., 68.
ELLIS, R., 85.
ELSDEN, J. V., 91.
Encrinites, 4.
Erratics, 21, 22.
Escrick, 23.
ETHERIDGE, R., 82.
FAIRBANK AND SONS, Messrs., 40.
FAIRLEY, T., 14, 17, 81, 84, 90.
FAREY, J., 16, 70, 71.
Farnham, 13, 24, 38.
Fault at Goldsborough Mill, 29.
Nidd Rock, Probable, 29.
Faults, 26-30, 49.
Features of the country, 1, 2.
in the Drift, 22, 23.
Fewston, 25.
Fissures in the Limestone, 13.
FITTON, W. H., 73.
Flagstones, 36.
Flaxby, 22.
FLETCHER, J. S., 90.
FLOYER, Sir J., 65.
Follifoot Grits, 5, 27, 28.
Moor, 5, 27.
Fossils from Aldfield, 14.
the Cayton Gill Beds,
6, 7.
Goldsborough, 15.
the Lias, 19.
Fountains Abbey, 1, 6, 9, 10, 13, 28,
30, 31, 33.
Four Lane Ends, 6.
FRENCH, J., 64, 67.
Freshwater deposit, 24.
FULLER, T., 64.
GAIRDNER, M., 73.
GALE, T., 65.
GARNETT, T., 68.

- GARROD, A. E., 89.
 GASCOIGNE, R., 84.
 GEIKIE, J., 81.
 GEORGE, E. S., 71.
 GIBSON, E., 64.
 Glacial Beds, 21-23, 30.
 Glacier of the Vale of York, 23.
 GLOVER, R. M., 77.
 Goldsborough, 15, 24, 29, 30.
 ———— Mill, 13, 14, 29.
 ———— Moor, 24.
 GOODCHILD, J. G., 83.
 GOUGH, R., 64.
 GRAFTON, 25, 38.
 GRAINGE, W., 77, 78, 80, 88.
 GRAINGE, W. D'O'LYLY, 91.
 Grantley Hall, 31.
 GRANVILLE, A. B., 74.
 Gravel and sand, 22, 23, 24, 38.
 GRAY, J. W., 88.
 Great Ouseburn, 1, 24.
 GREEN, A. H., 80, 81, 82, 83.
 Green Hammerton, 16, 38.
 GREENOUGH, G. B., 78.
 GREENWELL, A., 91.
 Grewelthorpe Moor, 60.
 GRIM, H., 93.
 Grimbald Crag, 13.
 GUNN, W., 83.
 Gypsum, 14, 17, 38.
 Haddockstones, 10, 31.
 ———— Grainge, 28.
 HAIGH, —, 53.
 Halfway House, Easingwold, 19.
 Hampsthwaite, 6.
 HARDWICKE, H. J., 85.
 HARGROVE, E., 67.
 Harlow Carr, 26, 43.
 ———— Hill, 1, 26, 30, 45.
 HARMER, F. W., 93.
 HARRISON, W. J., 83, 84.
 Harrogate, 1, 2, 4, 5, 6, 22, 26, 27,
 28, 30, 33, 37, 39, 42-52, 53.
 ———— End, 6, 8.
 ———— Roadstone Series, 4, 5,
 44.
 Haverthwaites House, Easingwold,
 20.
 HAWKESWORTH, E., 91, 92.
 Hazel Hill, Sawley, 7.
 HEARNE, T., 66.
 Hebden Beck, 31.
 Hell Wath, 13.
 Helperby, 56.
 HENDERSON, T. F., 86.
 HEYWOOD, A., 93.
 HIGGINS, DR., 68.
 High Brooms, 56.
 ———— Catton, 22.
 ———— Harrogate, 45, 53.
 HIND, WHEELTON, 2, 4, 7, 91, 92, 93.
 HINDE, G. J., 86.
 HIRSCHFELD, J., 82.
 History of the Harrogate Springs,
 42-52.
 HOBKIRK, C. P., 81.
 HOFFMANN, F., 66.
 HOFMANN, A. W., 76, 77.
 HOLGATE, B., 85, 87, 91.
 HOLLAND, T. P., 64.
 Hollin Hall, near Ripon, 24.
 HOLLINS, T., 77.
 HOLME, —, 37.
 HOLROYD, W. F., 90.
 Holtby, 22.
 Hookstone Wood, 5.
 Horsley Dike, 31.
 How Hill, near Fountains Abbey,
 22.
 ———— Harrogate, 4, 26.
 HOWARTH, J. H., 91, 92, 93.
 Howe Hill, Easingwold, 19.
 HOWELL, H. H., 85.
 Huby, 57.
 ———— Burn Farm, 17, 57.
 HUDLESTON, W. H., 5, 52, 85, 90.
 HULL, E., 77, 79, 83, 84.
 Humber, The, 1, 23.
 Hunsingore, 16.
 HUNTER, A., 69, 70, 72.
 HUNTER, J., 72.
 Hutton Moor, 22.
 HYMAS, F., 37.
 HYMAS, J. T., 58, 59.
 INCHBOLD, T., 72.
 Ingerthorpe, 55.
 INGLE, H., 84.
 Ingmanthorpe, 54.
 INGRAM, DALE, 68.
 Iron Waters, Table of, 46, 48.
 Ironstone, 20.
 JAMES, M. P., 85.
 JOHNS, C., 92, 93.
 JOHNSON, J., 75.
 JOHNSTONE, M. N., 84.
 JONES, T. R., 78.
 Junction of Carboniferous and
 Permian, 8, 9, 29.
 KAYE, J. R., 58, 92.
 KENDALL, P. F., 2, 23, 56, 88, 89,
 90, 91, 92, 93.
 KENNEDY, C. L., 84.
 KENNION, G., 75, 76, 77.
 Keuper Sandstone and Marl, 17.
 Kilburn, 22.
 Killinghall, 28.
 ———— Mills, 9.
 ———— Moor, 28.
 Kinder Scout Grit, 5, 27.
 KING, F. D., 87.
 Kirk Deighton, 54.
 ———— Hammerton, 17, 58.

- KIRKBY, J. W., 77.
 Kirkby Malzeard, 60.
 KIRKLEY, J. W., 40.
 Kirklington, 22.
 KIRWAN, R., 69.
 Knaresborough, 1, 8, 9, 11, 13, 14, 15,
 25, 28, 31, 34, 36, 37, 38, 39.
 KNOWLTON, J., 67.
 Knox Farm, 53.
 ——— Mill, 9.

 Lacustrine clay, 23, 24.
 Lake District Boulders, 22.
 LAMPLUGH, G. H., 91, 93.
 LANGDALE, W., 75.
 Laver, River, 31.
 LAVIS, H. J. JOHNSON, 88.
 LEBOUR, G. A., 82.
 LEE, E., 73, 74, 76.
 LEE, H., 53.
 LEECH, D. G., 91.
 Leeming Bar, 59.
 LEES, F. A., 83, 87, 91.
 LEIGH, C., 65.
 LEWIS, A. L., 83.
 LEWIS, H. C., 86, 89.
 LEWIS, S., 76.
 Lias, 19, 20.
 LIDDELL, J., 88.
 Lime, 36.
 Lindrick, 22.
 Lingerfield, 9.
 LISTER, M., 65.
 Little Ouseburn, 16.
 LOCKYER, Sir NORMAN, 93.
 Loftus Hill, near Staveley, 55.
 Londonderry, 59.
 Long Crag, near Harrogate, 6.
 Low Harrogate, 5, 45.
 Lower Lias, 19.
 ——— Limestone, 12-14.
 ——— Marl, 11.
 LUCAS, C., 67.
 LUCAS, J., 80, 81, 82, 83, 85, 87.
 LUCAS, W., 75.
 Lumley Moor, 39.

 MACKENZIE, P., 70.
 Mackershaw Woods, 31.
 MACKINTOSH, D., 78, 80, 84.
 MACPHERSON, J., 79, 80.
 Magnesian Limestone, 12-15, 30, 35,
 36, 40.
 Mammalian remains, 24.
 MANSON, D., 79.
 Markenfield Hall, 13.
 Markington, 13, 28, 56.
 ——— Beck, 31.
 Marl pits, 13.
 Marls, Permian, 11.
 MAER, J. E., 86.
 MARSHALL, W., 68, 69, 71.
 Marton 16.
 ——— cum Grafton, 22.
 Marton le Moor, 56.
 Masham Moor, 59, 60.
 MIALI, L. C., 81.
 Middle Lias, 19, 20, 36, 40.
 ——— Marl, 14.
 MILBURN, M. M., 76.
 MILES, C. E., 85.
 MILL, H. R., 92.
 MILLER, J., 71.
 Millstone Grit, 5-10, 29, 30, 35, 44,
 45.
 Minerals, 33-41.
 MITCHELL, C. A., 91.
 MITCHELL, T. C., 87.
 Monkton Mains, 14.
 Monoliths of Millstone Grit, 9.
 MONRO, ALEX., 67.
 MONRO, D., 68.
 MONTAGUE, —, 55.
 Mother Shipton's Cave, 13.
 Moulding Sands, 12, 38.
 Mountain Limestone, 44.
 MURCHISON, Sir R. I., 76, 79.
 MURRAY, J., 70.
 MUSPRATT, S., 78, 79.
 MYRTLE, A. S., 79, 80, 89.
 Myton, 57.

 NEALE, G., 66.
 New Cover, Scriven, 12.
 New Red Sandstone, 16, 17.
 Newby, 31.
 ——— Hall, 56.
 Newsome Bridge Quarry, 8.
 Newton Kyme, 38.
 ——— on Ouse, 17, 23, 58.
 Nidd Hall, 28, 32.
 ——— River, 6, 8, 9, 11, 12, 14, 21,
 22, 25, 27, 28, 29, 31, 32, 38.
 ——— Rock, 28, 29, 32.
 Nodules in the limestone, 13.
 Northallerton, 14.
 North Otterington, 22.
 ——— Stainley, 22.

 Oak Beck, 6, 27, 28, 39.
 OLIVER, G., 84, 86.
 Origin of the Harrogate Springs
 42-52.
 Ornbam's Hall, 14.
Orthoceras, 7.
 OSANN, E., 72.
 Osmotherley, 22.
 Oulston Spring, 40.
 Ouse River, 1, 41.
 Outliers of Magnesian Limestone,
 23.
 Overton, 24.
 OWEN, W., 67.
 OWSTON, T., 57.

 PALLISER, P., 74.
 Pannal, 27, 39, 45.
 ——— Ash, 45.

- Park House, Newton-on-Ouse, 23.
 Pateley Bridge, 7, 38.
 PATTERSON, J., 41.
 PAUL, G., 91.
 Paving stones, 36.
 Peat, 24.
 Pendleside Series, 4, 45.
 PENNANT, T., 69.
 Permian Rocks, 11–15, 28, 29.
 PHILLIPS, J., 4, 49, 71, 72, 73, 74,
 76, 77, 78, 82.
 PHILLIPS, W., 71.
 Physical geography, 1, 2.
 — structure, 26–32.
 PICKLER, W., 82.
 PIGGOTT, G. W. R., 76, 77.
 Pill Moor, 57.
 PLATNAUER, H. M., 87, 89, 91.
Pleurodontilus nodoso-carinatus, 7.
 Plumpton, 9, 22, 28.
 — Grit, 8–10, 27, 28.
 — Rocks, 44.
 Post-Glacial Beds, 23–25.
 Pott Beck, Masham Moor, 39, 59.
Productus horridus, 13.
 Prospect Tunnel, Harrogate, 27.

 Quarry Moor, 13.

 Rainfall, 39.
 RAMSAY, Sir A. C., 81.
 RANKIN, W. M., 92.
 Raskelf, 17, 18, 19, 57.
 READE, T. M., 85, 90.
 RENNIE, G., 69.
 Report of the Harrogate Improve-
 ment Commissioners, 77.
 — Trial, The King v.
 Thackwray, 73
 Reservoirs of the Harrogate Cor-
 poration, 39.
 REYNOLDS, R., 90.
 Rhætic Beds, 17, 18.
Rhinoceros tichorhinus, 24.
 Rhodes House, near Follifoot, 6.
 Ridges in the Drift, 22, 23.
 Ripley, 9, 21, 22, 25, 28, 30, 31.
 — Station, 28.
 Ripon, 1, 11, 13, 16, 17, 22, 24, 25, 34,
 36, 37, 38, 39, 45, 56.
 River courses, Alteration of, 23, 31,
 32.
 — Systems, 1.
 — Terraces, 25.
 Road material, 38.
 ROBERTS, A., 89, 91.
 Roecliffe, 9.
 ROOKE, H., 68.
 Rothliegende, Supposed, 8.
 ROTUREAU, A., 78.
 Roundhills Reservoir, Masham
 Moor, 39, 60.
 RÜCKER, A. W., 87, 88.

 Rudding Park, 27.
 Rudfarlington, 27, 28.
 — Wood, 27.
 RUSSEL, R., 67.
 RUSSELL, A. G., 88.
 RUSSELL, R., 79, 80, 82, 83.
 RUTTY, J., 67.

 SABINE, Sir E., 80.
 St. Helens Quarry, 8, 9, 11.
 St. Mungo's Well, 35.
 Saltergate Hill, 6, 28.
 Salts in the Harrogate Springs,
 Amount of, 52.
 Sand and Gravel, 22, 23, 38.
 Sand-pit at Brearton, 11.
 SAUNDERS, W., 69.
 Sawley, 6, 7.
 — Hall, 31.
 Scar Limestone, 45.
 Scarah Moor, 6, 28, 30.
 Scargill Reservoir, 7, 39.
 Scriven, 9, 12, 28, 39.
 SCUDAMORE, C., 71.
 Section of lacustrine deposit, 24.
 — Rhætic Beds, 18.
 Sections of borings and wells, 53–60.
 SEDGWICK, A., 12, 37, 71, 72.
 Selby, 23.
 Sessay, 57.
 Shafts in the Bunter Sandstone,
 16, 17.
 Shap Granite Boulders, 22.
 Shaw Green, 5, 26, 27, 45.
 SHAW, PETER, 66.
 SHEAHAN, J. J., 77, 80.
 SHIRREFF, J., 69.
 SHORT, T., 65, 66, 67.
 SIMPSON, W., 64.
 Sinderby, 22.
 Sinkings in the Bunter Sandstone,
 16, 17.
 Skell River, 13, 22, 25, 28, 31, 33.
 Sketch at Goldsborough Mill, 29.
 — of Newsome Bridge Quarry,
 8.
 — at Nidd Rock, 29.
 — of St. Helens Quarry, 9.
 — of sand-pit at Brearton, 11.
 — Scriven, 12.
 Skipton, 45.
 SMITH, A., 74, 75.
 SMITH, C. H., 74.
 SMITH, F. W., 91.
 SMITH, H. E., 76.
 SMITH, W., 70, 71.
 SMITH, W. G., 92.
 Solberge, 14.
 SORBY, H. C., 77.
 South Stainley, 9, 28, 31.
 SOWERBY, J., 69, 72.
 SOWERBY, J. DE C., 72.
 SPEIGHT, H., 89.

- SPENCE, J., 75.
 Spofforth, 9, 28, 31, 54.
 Spring House near Raskelf, 17.
 Springs, 33-35, 46-48.
 SQUIRE, W., 87.
 STANHOPE, M., 64.
 Starbeck, 5, 27, 39, 51, 54.
 Staveley, 24, 32, 36, 55.
 STEVENSON, Sir T., 34.
 STEVENSON, W., 75.
 Stillington, 18, 22.
 STRANGWAYS, C. Fox-, 79, 80, 81, 82,
 83, 84, 85, 86, 87, 90.
 Strata, Classification of the, 2, 3.
 Stray, The, 45.
 Strontianite, 38.
 Structure of the country, 26-32.
 Studley Park, 11, 13, 22, 31.
 STUKELEY, W., 66.
 Subdivisions of the strata, 3.
 SUGDEN, S., 80.
 Sulphur Waters, 42-52.
 ————— Table of, 46, 47, 48.
 SUMMERFIELD, R. A., 87.
 Superficial Deposits, 21-25.
 SWAIN, W. T., 88.
 Swale River, 1, 25.
 SWEETING, R. D. R., 86.

 Table of analyses of the Chalybeate
 Waters, 48.
 Table of analyses of the Sulphur
 Waters, 47.
 Table of Sections, 53-60.
 ————— Strata, 2, 3.
 Tadcaster, 38.
 TAIT, M., 87.
 TATE, A. N., 87.
 TATE, R., 82.
 TATE, T., 88, 89.
 TATE AND BLAKE, Messrs., 18, 19, 20.
 TAYLOR, J., 64.
 TEALL, J. J. H., 84.
 Teeth of Mammoth, 25.
 Temperature of the Harrogate
 Waters, 51.
 Ten Mile Hill near Tholthorpe, 23.
 TENNANT, S., 69.
 Thickness of the Boulder-clay, 21.
 ————— Follifoot Beds, 6.
 ————— Kinder Scout Grit,
 5.
 ————— Lower Limestone,
 12.
 ————— Plumpton Grit, 8.
 ————— Upper Lias, 20.
 Third Grit, 5, 27, 28.
 Thirsk, 22, 58.
 Tholthorpe, 22, 23, 24, 31.
 THOMAS, I., 15.
 THOMPSON, T. W., 88.
 THORESBY, R., 66.
 Thornton le Beans, 22.
 Thornton Moor House, 6, 28.
 THORPE, J., 79, 93.
 THORPE, T. E., 82, 84, 87, 88.
 THORPE, W., 74, 75, 76.
 Thorpe Green, 16.
 THRESH, J. C., 90.
 TICHBORNE, C. R. C., 85.
 TIDDEMAN, R. H., 87.
 Timble Gill, Fewston, 25.
 Tollerton, 24.
 TOOKE, A. W., 73.
 Topcliffe, 22.
 TOWNSEND, C. F., 91.
 Trias, 16, 17, 30, 40.
 TUKE, J., 69.
 TUTE, J. S., 7, 13, 14, 17, 24, 55, 56,
 79, 81, 83, 85, 86, 87, 88, 89.
 Tutt Beck, 9.

 Unconformity of the Carboniferous
 and Permian, 8, 9.
 Underground stream, 13.
 Union Steam Flour Mills, Easing-
 wold, 17.
 Upper Lias, 20.
 ————— Limestone, 14, 15.
 ————— Marl, 15.
 Ure River, 1, 25, 31, 38, 39.

 Vale of York, 1, 17, 21, 22, 23, 24,
 30, 41.
 Valleys, 31, 32.
 VAUGHAN, A., 93.
 VILLIERS, J., 58.
 VINE, G. R., 86.

 WALBRAN, J. R., 74, 75.
 WALKER, J., 68.
 Walkingham Hall, 31.
 Walshford Bridge, 25.
 WARD, J. C., 8, 9, 29, 79, 80, 81, 82.
 WARING, E. J., 83.
 Warp clay, 23, 24, 31.
 Water Supply, 38-41.
 Waters, Mineral, 33-35.
 WATSON, R., 68.
 WEATHERHEAD, W., 74.
 WEBER, F. P., 90, 93.
 WEBER, H., 81, 85, 90, 93.
 Well, 14, 36.
 Well sections, 53-60.
 WEST, W., 71, 73, 75.
 Wharfe River, 4, 50.
 WHEATER, W., 88.
 WHELLAN, T., 77.
 WHITAKER, W., 82.
 WHITE, W. H., 91.
 WHITELEY, R. L., 86.
 Whorlton, 22.
 Wighill, 22, 55.
 WILLAN, R., 68.
 WILLIAMS, J. W., 71.
 WILSON, A. E., 84.

- WILSON, E., 82, 84.
WILSON, J. H., 85.
WINCH, N. J., 70, 71.
WITTIE, R., 65.
WOOD, J., 67.
WOOD, S. V., 80, 81, 84.
WOODWARD, H., 93.
WOODWARD, H. B., 82.
- Wormald Green, 13, 36.
WRIGHT, G. F., 88.
- YEO, J. B., 86, 92.
Yoredale, 2, 4.
York, 1, 17, 22, 23, 30, 41.
- Zones of the Lias, 19, 20.
-

UNIVERSITY OF LANCASTER
LIBRARY

Due for return by:

CANCELLED
1982

CANCELLED
4 OCT 1982

OX50236393 0001 01
GEOL SURVEY/HARROGATE. 2ND ED
DGVe

Book

